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NUCLEAR SAFETY TECHNICAL REPORT

SAFETY ANALYSIS FOR THE BUILDING 991 COMPLEX FINAL SAFETY ANALYSIS REPORT

Rocky Mountain Remediation Services
Nuclear Safety
Rocky Flats Environmental Technology Site

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EXECUTIVE SUMMARY

The purpose of this Nuclear Safety Technical Report (NSTR) is to document the hazard identification, hazard evaluation, accident analysis, and control selection process associated with the Safety Analysis in support of the Building 991 Complex Final Safety Analysis Report (FSAR) The primary missions of the Building 991 Complex are (1) to receive, stage, and ship Type B shipping containers containing Special Nuclear Material (SNM), and (2) to receive, store, and ship Pipe Overpack Containers (POCs), transuranic (TRU) waste containers, and low-level waste (LLW) containers The risks associated with these activities are evaluated in this report

The Building 991 Complex was previously classified as a moderate hazard facility per DOE Order 5481 1B, *Safety Analysis and Review System*, and a nonreactor nuclear facility per DOE Order 5480 5, *Safety of Nuclear Facilities* Based upon the inventory of radionuclides present during the accomplishment of the new mission of the Building 991 Complex, the complex is now classified as a Hazard Category 2 nuclear facility in accordance with the inventory thresholds defined in Attachment 1 of DOE-STD-1027-92, *Hazard Characterization and Accident Analysis Techniques for Compliance with DOE Order 5480 23, Nuclear Safety Analysis Reports*

An activity-based hazards identification and evaluation of the Building 991 Complex was performed to identify, evaluate, and control hazards associated with SNM and waste container receipt, storage or staging, transfer and shipping operations The hazard identification process identified 44 hazards or energy sources in the Building 991 Complex Of these, 22 hazards or energy sources were determined to be standard industrial hazards that were to be controlled by the Site Safety Management Programs (SMPs) and did not require further evaluation For the remaining 22 hazards/energy sources, the hazard evaluation process determined how each of the hazards or energy sources could lead to a release of hazardous material The process identified 37 general accident scenarios leading to releases due to failures of radioactive material containers These 37 general accident scenarios could be grouped into seven accident scenario categories The seven postulated accident categories initially considered for evaluation were (1) material fires (*i e*, pyrophoric material fires), (2) facility fires, (3) spills, (4) punctures, (5) container explosions (*i e*, internal hydrogen explosions), (6) facility explosions, and (7) criticality events

Each of the 37 general accident scenarios were evaluated for each of the identified radioactive material containers (*i e*, SNM Type B shipping containers, POCs, TRU waste containers, metal LLW containers, and wooden LLW crates) under each of the general activities to be performed in the complex using a hazard evaluation process consistent with that defined in DOE-STD-3009-94, *Preparation Guide for U S Department of Energy Non-reactor Nuclear Facility Safety Analysis Reports* The general activities assessed were characterization, treatment, and disposition of excess chemicals, construction, waste generation (*e g*, drum

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crushing operations, filter change-out), maintenance, receipt, staging, and shipment of SNM, receipt, storage, transfer, and shipment of waste, routine activities (*e g* , utility operations, tenant activities), and surveillance This more detailed hazard evaluation process evaluated 1,480 activity / container / scenario combinations These 1,480 combinations were reduced down to 164 credible scenario combinations in the hazard evaluation process These 164 credible scenarios were examined in the determination of bounding accident scenarios to be carried forward into the accident analysis process

Twelve accident scenarios were defined in the bounding scenario determination process with subsequent area-specific considerations (*i e* , bounding scenarios were examined for further distinction related to location of the scenario in the Building 991 Complex) The scenarios were analyzed to determine frequency of initiating events (including internal, natural phenomena, and external events), the radioactive material releases for scenarios, the consequences of the releases, and the risk to the public (as represented by maximally exposed off-site individual (MOI), the collocated worker at or beyond 100 meters (CW), and the immediate worker (IW)) The postulated accident scenario risk classes (as defined in DOE-STD-3011-94, *Guidance for Preparation of DOE 5480 22 (TSR) and DOE 5480 23 (SAR) Implementation Plans*) determined from the analyses credited preventive and mitigative features currently present in the Building 991 Complex

Postulated accident scenarios found to be Risk Class I (major risk) or Risk Class II (serious risk) were further examined to determine if any preventive or mitigative features exist which, if implemented, could reduce the scenario risk to Risk Class III (marginal risk) or Risk Class IV (negligible risk) These features were noted for inclusion in the control set defined by the Technical Safety Requirements (TSRs) of the FSAR The risk associated with postulated accidents scenarios found to be Risk Class III or Risk Class IV are low enough to not require further evaluation

As stated above, a total of twelve accident scenarios (nine operational accidents and three natural phenomena accidents) were analyzed Of these twelve scenarios, seven scenario evaluations initially resulted in a Risk Class I or Risk Class II to either the MOI, the CW, or the IW (the puncture scenario had one of its four evaluated cases result in a Risk Class I or II to either the MOI, CW, or the IW) Of the accident scenarios evaluated, none resulted in a MOI radiological dose consequence exceeding 5 rem (the highest MOI radiological dose was 2 6 rem) The highest CW radiological dose consequence was 350 rem for an *extremely unlikely* TRU waste container explosion event

The accident scenarios yielding Risk Class I or Risk Class II results are presented in the table below (high risk receptors shaded and shown in bold text) The initial risk determinations are presented for each of the receptors as determined during the accident analysis In some cases, the dominant accident scenarios were further mitigated by crediting ventilation system high efficiency particulate air (HEPA) filtration, as indicated in the table For other cases, a more realistic risk class determination for each high risk receptor is presented with an explanation of the analysis conservatism that was removed

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Based on the information in the table and after analysis conservatism is removed, the highest risk non-operational accident scenario deals with a Design Basis Earthquake (DBE) and yields a Risk Class II to the CW (*unlikely* frequency, *moderate* consequences) and a Risk Class II to the IW (*unlikely* frequency, *moderate* consequences) The highest risk operational accident scenario involves the puncture of two 55-gallon TRU drums This scenario yields a Risk Class II to the CW (*unlikely* frequency, *moderate* consequences) _A container explosion presents the final accident scenario that yielded high risk to a receptor This scenario resulted in a Risk Class II to the CW (*extremely unlikely* frequency, *high* consequences)

Risk Dominant Accident Scenario Results

		INITIAL RISK		RISK AFTER CONSERVATISM REMOVED		
SCENARIO	**RECEPTOR**	**RISK CLASS**	**FREQ. / CONSQ.**	**RISK CLASS**	**FREQ / CONSQ**	**CONSERVATISM REMOVED**
1 MW fire involving 3 TRU waste drums	MOI CW IW	[illegible] [illegible] III	U / 0 026 rem U / 35 rem	III III	U / 0 00026 rem U / 0 035 rem	Consequences reduced crediting a single stage of HEPA filtration
2 MW fire involving 6 TRU waste drums	MOI CW IW	III II IV	EU / 0 52 rem EU / [illegible] rem	IV	EU / 0 071 rem	Consequences reduced crediting a single stage of HEPA filtration
Medium to large fire involving 4 LLW crates	MOI CW IW	III II III	U / 0 0048 rem U / 0 66 rem	III	U / 0 16 rem	More realistic container material-at-risk
Spill involving a pallet of TRU waste drums	MOI CW IW	III [illegible] III	A / 0 023 rem A / [illegible] rem	III	A / 0 0031 rem	Consequences reduced crediting a single stage of HEPA filtration
Puncture of 2 TRU waste drums, dock doors open	MOI CW IW	III II III	U / 0 046 rem U / 6 2 rem	II	U / [illegible]	Consequences reduced assuming only a single container punctured
Puncture of 2 TRU waste drums, dock doors closed	MOI CW IW	III II III	U / 0 046 rem U / 6 2 rem	III	U / 0 0062 rem	Consequences reduced crediting a single stage of HEPA filtration
Container explosion of 1 TRU waste box dock doors open	MOI CW IW	III II III	EU / 2 6 rem EU / 350 rem	II	EU / [illegible] rem	More likely container (drum), more appropriate material modeling assumptions
Container explosion of 1 TRU waste box dock doors closed	MOI CW IW	III II III	EU / 2 6 rem EU / 350 rem	IV	EU / 0 35 rem	Consequences reduced crediting a single stage of HEPA filtration
DBE event-induced spill	MOI CW IW	II [illegible] II	U / 0 35 rem U / 48 rem	III II II	U / 0 018 rem U / 3 0 rem	More realistic container material-at-risk, Median χ/Q rather than 95[th] percentile

Rationale for the acceptability of these results is presented in a later section of this report The Safety Analysis that follows requires that certain preventive and mitigative controls be maintained These controls have been developed in Appendix A, *Building 991 Complex Technical Safety Requirements*, of the FSAR The TSRs include three Limiting Conditions for Operation (LCOs) and nine Administrative Controls (ACs) ACs are specific administrative controls/limits (*i e*, the administrative equivalent of a hardware requirement) and are more precise and discrete than the program elements of a SMP Specific program elements of SMPs that are relied on, as identified in the safety analysis, are specified in Chapter 3, *Safety*

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Management Programs, of the Buıldıng 991 Complex FSAR Operatıon of the Buıldıng 991 Complex ın conformance wıth the lımıts derıved by thıs Safety Analysıs assures there wıll be no undue rısk to workers and the publıc

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ACRONYMS

A	Anticipated [event frequency bin]
A	Assumption
A	Code for Waste Generation (activity)
ADB	Analyzed in Detail Below
ALARA	As-Low-As-Reasonably-Achievable
AOL	Administrative Operating Limit
APC	Atmospheric Pressure Change
ARRF	Airborne Respirable Release Fraction
B	Code for Receipt, Staging, and Shipment of Special Nuclear Material (activity)
BDBE	Beyond Design Basis Earthquake
BIO	Basis for Interim Operation
BR	Breathing Rate
C	Code for Receipt, Storage, Transfer, and Shipment of Waste (activity)
C	Credited [protective feature]
CEDE	Committed Effective Dose Equivalent
CEXPLO	Container Explosion (scenario type)
CFR	Code of Federal Regulation
CHEM	Characterization, Treatment, and Disposition of Excess Chemicals (activity)
CON	Construction (activity)
CONFIG	Configuration Management (SMP)
CRIT	Criticality Safety (SMP)
CRIT	Criticality (scenario type)
CW	Collocated Worker
D	Code for Surveillance (activity)
D	Defense-In-Depth [protective feature]
DBE	Design Basis Earthquake
DBFL	Design Basis Flood
DCF	Dose Conversion Factor
DOE	Department Of Energy
DOT	Department Of Transportation
DR	Damage Ratio

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E	Code for Characterization, Treatment, and Disposition of Excess Chemicals (activity)
E	Extremely Unlikely [event frequency bin]
EE	External Event
EFCOG	Energy Facility Contractors Group
EPA	Environmental Protection Agency
EPWM	Environmental Protection and Waste Management (SMP)
ER	Emergency Response (SMP)
ERPG	Emergency Response Planning Guideline

F	Code for Construction (activity)
F	Feature (protective feature)
FEXPLO	Facility Explosion (scenario type)
FFIRE	Facility Fire (scenario type)
FHA	Fire Hazards Analysis
FIRE	Fire Protection (SMP)
FPE	Fire Protection Engineering
FSAR	Final Safety Analysis Report

G	Code for Maintenance (activity)
G	General Assumption
GEN	Waste Generation (activity)

H	Code for Routine Activities (activity)
H	High [consequence bin]
HEPA	High Efficiency Particulate Air [filters]

ICMS	Integrated Chemical Management System
IDC	Item Description Code
IE	Internal Event
IST	Initial [respirable] Source Term
IW	Immediate Worker

L	Low [consequence bin]
LCO	Limiting Condition for Operation
LLW	Low-Level Waste
LPF	Leakpath Factor

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LS/DW	Life Safety / Disaster Warning [system]
M	Moderate [consequence bin]
M	Mitigative [protective feature]
MAINT	Maintenance (SMP)
MAINT	Maintenance (activity)
MAR	Material-At-Risk
MFIRE	Material Fire (scenario type)
MOI	Maximum [exposed] Off-site Individual
NA	Not Applicable
NC	Not Credible
NDT	Non-Destructive Testing
NFPA	National Fire Protection Association
NMSL	Nuclear Material Safety Limit
NPH	Natural Phenomena Hazard
NSTR	Nuclear Safety Technical Report
NUC	Nuclear Safety (SMP)
OR	Occurrence Reporting (SMP)
ORG	Organization and Management (SMP)
P	Preventive [protective feature]
PC	Performance Category
PCB	Polychlorinated-Biphenyl
PDC	Plume Duration Correction [factor]
PHA	Preliminary Hazards Analysis
POC	Pipe Overpack Container
PSM	Process Safety Management
PUNCT	Puncture (scenario type)
QA	Quality Assurance (SMP)
R	Requirement
RA	Routine Activities (activity)
RAD	Radiation Protection (SMP)
RCRA	Resource Conservation and Recovery Act

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RMDC	Records Management and Document Control (SMP)
RQ	Reportable Quantity
SAR	Safety Analysis Report
SARAH	Safety Analysis and Risk Assessment Handbook
SC	System Category
S&IH	Safety and Industrial Hygiene (SMP)
SMP	Safety Management Program
SNM	Special Nuclear Material
SNM	Receipt, Staging, and Shipment of Special Nuclear Material (activity)
SPILL	Spill (scenario type)
SSC	Structure, System, and Component
SURV	Surveillance (activity)
SWB	Standard Waste Box
TPQ	Threshold Planning Quantity
TQ	Threshold Quantity
TRAIN	Training (SMP)
TRANS	Transportation (SMP)
TRU	Transuranic
TRUPACT	Transuranic Package Transporter
TSCA	Toxic Substances Control Act
TSR	Technical Safety Requirement
U	Unlikely [event frequency bin]
UCL	Upper Confidence Limit
USQD	Unreviewed Safety Question Determination
WASTE	Receipt, Storage, Transfer, and Shipment of Waste (activity)
WEMS	Waste and Environmental Management System
WFC	Waste Form Code
WG Pu	Weapons Grade Plutonium
WORK	Work Control (SMP)
χ/Q	Chi-over-Q (atmospheric dispersion factor)

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1. HAZARD AND ACCIDENT ANALYSIS INTRODUCTION

Various hazards are currently present in the Building 991 Complex and will be discussed in this chapter The most significant hazards with potential to impact public risk found in the Building 991 Complex are associated with radioactive materials in the form of Category I and II Special Nuclear Materials (SNM) and radioactive wastes The Category I and II SNM is only found in Department of Transportation (DOT) approved, Type B shipping containers, which are received by Building 991 and staged in the facility in preparation for off-site shipment The radioactive waste materials are primarily stored in 55-gallon drums meeting on-site shipping specifications and/or DOT specifications, however, the facility may receive and store Transuranic Package Transporter II (TRUPACT II) Standard Waste Boxes (SWBs) and DOT-7A, Type A Metal Waste Boxes The 55-gallon waste drums may be standard Transuranic (TRU) waste drums or Pipe Overpack Containers (POCs) In addition, wooden Low-Level Waste (LLW) crates may be received and stored in the Building 991 West Dock Canopy Area

This Nuclear Safety Technical Report (NSTR) addresses the identification and the evaluation of the hazards associated with the Building 991 Complex primary mission movement and storage of hazardous radioactive materials/waste It evaluates the consequences of postulated accidents leading to radiological and/or toxicological (chemical) releases that may be caused by internal, external, and natural phenomena-related events The evaluated potential consequences and risks (frequency times consequence) to workers, both immediate and collocated, and the public, as represented by the maximum [exposed] off-site individual (MOI), are presented Preventive and/or mitigative features (structures, systems, and components (SSCs) or elements of administrative programs) credited to reduce risk by lowering postulated accident frequencies and/or by reducing receptor consequences have also been identified so that an appropriate set of operational controls could be derived In addition, discussions addressing hazard identification, hazard evaluation, accident analysis methodology, risk classification methodology, and final nuclear facility hazard classification are presented Appendix A of this NSTR provides the supporting calculations for the analyses that follow

2. REQUIREMENTS

The standards, regulations, and DOE Orders reviewed in support of the development of the authorization basis for the Building 991 Complex are listed below Only portions of the listed documents are relevant to the Final Safety Analysis Report (FSAR), namely, those that cover requirements pertinent to FSAR preparation, hazard identification and evaluation, Safety Analysis, risk classification, nuclear facility hazard classification, and operational controls A comprehensive listing of standards and regulations addressing occupational safety and environmental protection is not provided

- *Facility Safety*, DOE Order 420 1 (Ref 1)

  This Order addresses operational controls dealing with Natural Phenomena Hazards Mitigation, Fire Protection, General Design Criteria, and Criticality Safety

- *Nuclear Safety Analysis Reports*, DOE Order 5480 23 (Ref 2)

  This Order specifies the requirement for FSAR preparation for nuclear facilities The Order also specifies that the FSAR should include identification and evaluation of both nuclear and non nuclear hazards

- *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480 23, Nuclear Safety Analysis Reports*, DOE Standard 1027-92 (Ref 3)

  This Standard addresses nuclear facility hazard classification by defining threshold gram / curie facility inventory limits for various radionuclides corresponding to Hazard Category 2 and 3 nuclear facilities.

- *Guidance for Preparation of DOE 5480 22 (TSR) and DOE 5480 23 (SAR) Implementation Plans*, DOE Standard 3011-94 (Ref 4)

  This Standard addresses hazard identification and evaluation by providing guidance on performing a Preliminary Hazards Analysis (PHA) The Standard also addresses risk classification by defining candidate consequence evaluation guidelines and risk categories for postulated accident scenarios

- *Preparation Guide for U S Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, DOE Standard 3009-94 (Ref 5)

  This Standard addresses FSAR preparation by providing guidance on the implementation of DOE Order 5480 23 The Standard also addresses hazard identification / evaluation and Safety Analysis by providing guidance on the analysis techniques and level of detail

- *Nuclear Safety Management Quality Assurance Requirements,* Code of Federal Regulations, 10 CFR 830, Department of Energy, Washington, D C , 1995 (Ref 6)

  This Code of Federal Regulation (CFR) subpart addresses operational controls by prescribing quality assurance requirements that are generally applicable to DOE nuclear facilities

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3. METHODOLOGY

3.1 OVERVIEW OF THE HAZARDS AND ACCIDENT ANALYSIS PROCESS

The Safety Analysis presented in this chapter uses a Preliminary Hazard Analysis (PHA) technique to identify and evaluate the hazards and postulated accident scenarios associated with the Building 991 Complex This technique begins by identifying existing or potential hazards (*e g*, radioactive sources, radioactive wastes, chemicals, or non-material hazards (*e g*, thermal energy sources, pressure sources, electrical energy sources)) in terms of quantity, form, packaging, location, affected or affecting activities, and recognized preventive and/or mitigative features (SSCs or elements of administrative programs) associated with the hazard

Based on the information developed by the PHA and presented in the hazards description table, determinations are made on whether further evaluation of specific hazards are necessary In general, no further evaluation is performed on those hazards (1) that could be characterized as Standard Industrial Hazards and (2) that have limited impact on postulated accident initiation frequency, accident mitigation, and accident consequences Industrial hazards that could only lead to occupational injuries or illnesses are addressed by the Industrial Hygiene and Safety program, as discussed in Chapter 3, *Safety Management Programs*, of the FSAR

For those hazards determined to require further evaluation, a hazards evaluation matrix is developed relating identified Building 991 Complex activities with corresponding hazards in order to derive postulated accident scenarios For each postulated accident scenario, the hazards evaluation matrix presents (1) scenario descriptive information including the corresponding activity and hazard leading to the scenario, (2) a categorization of the accident type, and (3) a qualitative assessment of scenario frequency, consequences, and risk class assuming identified, inherent preventive and mitigative features are in place Based on the information presented in the hazards evaluation matrix, postulated accident scenarios of higher risk are selected as candidate, bounding accident scenarios for further, detailed evaluation Bounding accident scenarios are identified for each of those postulated accident scenarios that are not carried forward for further analysis Any inherent preventive and/or mitigative features associated with the bounded scenarios that resulted in the scenario being low risk are assigned to the bounding scenarios in order to carry forward all credited preventive and mitigative features

In some cases, a bounding accident scenario qualitative frequency assessment may be further refined using event tree methodology displaying accident progression and impact of identified preventive and/or mitigative features In all cases, the bounding accident scenario qualitative consequence assessment is refined using Site consequence evaluation tools Quantitative estimates of scenario initial [respirable] source terms (ISTs) are determined based on (1) estimated damage ratios (DRs) associated with the postulated accident scenario, (2) bounding material-at-risk (MAR) estimates associated with analyzed activities and expected radioactive or chemical containers, and (3) airborne respirable release fractions (ARRFs) taken from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94 (Ref 7), for radioactive material release scenarios Scenario

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consequences are determined using (1) the ISTs, (2) estimates of applicable, facility leakpath factors, (3) Site atmospheric dispersion values, (4) receptor breathing rates, and (5) dose conversion factors for radioactive material releases Risk classifications of the bounding accident scenarios are then determined using a qualitative binning methodology based on the refined accident frequency and the newly determined quantitative estimates of accident consequence

In those cases where a bounding accident scenario is determined to present a high risk, evaluations are performed to identify any additional preventive or mitigative features that could be used to lower the scenario risk Risk dominant accident scenarios (*i e*, scenarios presenting the highest risk following the crediting of preventive and mitigative features) at the completion of the Safety Analysis evaluations are discussed in depth The adequacy of and vulnerability associated with credited preventive and mitigative features are presented for each risk dominant accident scenario

3.2 RISK CLASSIFICATION METHODOLOGY

The risks associated with postulated accident scenarios identified in the hazard evaluation tables or evaluated as bounding accident scenarios, as discussed in the previous section, can be categorized according to a combination of the scenario frequencies and consequences, as shown in Table 1 The categorization bins accident scenario risk into one of four risk classes For the purpose of this document, risks associated with Risk Class I accident scenarios are considered *major*, risks associated with Risk Class II scenarios are *serious*, Risk Class III accident scenario risks are *marginal*, and Risk Class IV accident scenario risks are considered *negligible* In addition, Risk Class I and II accident scenarios are considered to be ***high-risk*** scenarios, and Risk Class III and IV scenarios are considered to be *low-risk* scenarios The risk class associated with each of the accident scenarios to be identified and evaluated in the remainder of this report will be determined based on the Table 1 categorization scheme

Table 1 Risk Classes – Frequency Versus Consequence

	FREQUENCY OF OCCURRENCE		
CONSEQUENCE	**EXTREMELY UNLIKELY $<10^{-4}$ events/year**	**UNLIKELY between 10^{-4} and 10^{-2} events/year**	**ANTICIPATED $>10^{-2}$ events/year**
HIGH	II	I	I
MODERATE	III	II	I
LOW	IV	III	III

As stated earlier, inherent preventive and mitigative features required to be in place in order to maintain those Risk Class III and IV accident scenarios identified in the hazard evaluation tables as low-risk scenarios are carried forward with corresponding bounding accident scenarios Postulated accident scenarios identified in the hazard evaluation tables as Risk Class I or II scenarios are evaluated further to determine if any preventive or mitigative features exist, which if implemented, could reduce the scenario risk to a Risk Class III or IV category The collection of the credited preventive and mitigative features associated with initial and bounding scenario evaluations are carried forward into the development of the control set in Appendix A, *Building 991 Facility Technical Safety Requirements*

For those postulated accident scenarios that are evaluated to be Risk Class I or II scenarios and for which no preventive or mitigative features can be identified to reduce the scenario risk class, discussions related to the acceptability of the high-risk scenarios will be provided to ensure that the DOE is cognizant of facility risks

The application of Table 1 requires frequency bin and consequence bin assignments Consequence bin assignments will be discussed in the following sub-sections Frequency bin assignments are in accordance with DOE-STD-3011-94, *i e*, events more frequent than 10^{-2} per year are classified as *anticipated*, those with frequencies between 10^{-4} per year and 10^{-2} per year are classified as *unlikely*, and those less frequent than 10^{-4} per year are classified as *extremely unlikely* These frequency bin terms and assignments are consistent with DOE-STD-3009-94 qualitative likelihood classifications Low-likelihood high-risk scenarios are identified and discussed in those instances where the risk potential of the postulated accident scenario is judged to be significant relative to other credible scenarios Estimates of scenario frequency are generally qualitative but may be quantitatively defined, in some cases, with the use of event trees In cases where sufficient qualitative arguments for lower, accident scenario frequencies cannot be made, the scenario is classified as *anticipated*

3.2.1 Radiological Risk

Radiological dose consequence evaluations are performed using the following equation

$$\text{Dose} = \text{MAR} * \text{DR} * \text{ARRF} * \text{LPF} * \chi/Q * \text{BR} * \text{DCF} / \text{PDC}$$

where MAR is the radioactive material-at-risk (in grams, varies with scenario),
DR is the MAR damage ratio (varies with scenario),
ARRF is the airborne respirable release fraction (varies with form of radioactive material and scenario),
LPF is the facility leakpath factor (initially set to 1.0, varies with scenario),
χ/Q is the atmospheric dispersion factor (in s/m^3, varies with receptor and scenario),
BR is the receptor breathing rate (in m^3/s, set for heavy activity),
DCF is the radiological material dose conversion factor (in rem/gram, varies with material type), and
PDC is the plume duration correction factor (varies with scenario)

The PDC value is used for accident scenarios with a duration longer than 10 minutes (*e g*, large fires) The PDC value is used to modify the atmospheric dispersion value to correct for plume meander during the scenario The formula used for determining plume meander for longer duration releases is as follows

$$\text{PDC} = (\text{plume duration in minutes} / \text{time base})^{n}$$

where the time base is 10 minutes, "n" has a value of 0 2 if the plume duration is less than or equal to 60 minutes, otherwise, "n" has a value of 0 25

The atmospheric dispersion factors (χ/Q values) used in the radiological dose consequence evaluations are based on the receptor (*i e*, distance from the point of release), the type of accident scenario (*i e*, non-lofted plume or lofted plume), and modeling assumptions (*i e*, use of conservative 95th percentile values or median (50th percentile) values) In most cases, the atmospheric dispersion factors represent 95th percentile χ/Q values developed from an

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analysis of actual Site weather data Two receptors are identified for analysis (1) the public as represented by the maximum off-site individual (MOI) and (2) the collocated worker (CW)

The shortest possible distance from the Building 991 Complex to a MOI located at the Site boundary was determined to be 2,367 meters using tables found in RFP-5098, *Safety Analysis and Risk Assessment Handbook* (SARAH) (Ref 8) and this distance is used in the determination of MOI χ/Q values, in most cases, as part of radiological dose consequence evaluations As in the case of the CW, if the maximum χ/Q value is realized at a distance greater than 2,367 meters as a result of accident scenario modeling assumptions, the higher χ/Q value is used in the analysis For example, the maximum, 95th percentile χ/Q value for the MOI for a lofted plume occurs at a distance of 4,020 meters since the plume is "lofted" over the person at the Site boundary, as discussed in RFP-4965, *Reference Computations of Public Dose and Cancer Risk from Airborne Releases of Uranium and Class W Plutonium* (Ref 9)

The CW distance from the point of release, for most cases, has been set at 100 meters to be consistent with other safety analyses at the Site (*e g*, the Safety Analysis Reports (SARs) for Building 906 and the 750/904 Pads (Ref 10 and Ref 11, respectively)) This approach departs from the distance of 600 meters, which is suggested for use by DOE-STD-3011-94 (Ref 4) If the maximum χ/Q value is realized at a distance greater than 100 meters as a result of accident scenario modeling assumptions, the higher χ/Q value is used in the analysis For example, the maximum, median χ/Q value for the CW for a lofted plume occurs at a distance greater than 100 meters since the plume is "lofted" over the CW at 100 meters This overall approach for analyzing CW radiological dose consequences is more conservative than the DOE Standard approach and is appropriate for the following reasons (1) many CWs are closer to the Building 991 Complex than 600 meters due to the proximity of other Site facilities and the compactness of the Site, (2) the minimum distance used in formulations supporting the Gaussian plume atmospheric dispersion model is 100 meters, and (3) distances associated with evaluated maximum χ/Q values occurring beyond 100 meters are encompassed by the Site boundary

The term "immediate worker" (IW) is used to describe the individual who could be located in close proximity to the postulated accident scenario release location or who could be located within the Building 991 Complex For immediate worker consequences, a qualitative judgment of acute radiological effects is made It does not include latent cancer effects, per the guidance provided in DOE-STD-3009-94 (Ref 5) Scenario related effects (*e g*, burns from fires, injuries from energetic events) are discussed in the accident scenario summaries but are not included in the determination of the scenario risk class

Radiological dose consequences corresponding to the High, Moderate, and Low consequence bins identified in Table 1 are defined by the comparison criteria developed in DOE-STD-3011-94 and shown in Table 2 Radiological dose consequence bin thresholds for the MOI and CW are defined in terms of 50-year, Committed Effective Dose Equivalent (CEDE) radiological doses As stated above, radiological dose consequences for the IW are determined qualitatively, therefore, the radiological dose consequence bin thresholds for the IW are defined qualitatively

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Table 2 Radiological Dose Consequence Bin Thresholds

CONSEQUENCE	MOI DOSE CONSEQUENCE BIN THRESHOLD	CW DOSE CONSEQUENCE BIN THRESHOLD	IW CONSEQUENCE
HIGH	dose > 5 rem	dose >25 rem	prompt death {unmitigated/mitigated criticalities}
MODERATE	5 rem ≥ dose > 0 1 rem	25 rem ≥ dose > 0 5 rem	serious injury {unmitigated fires, explosions, spills, mitigated explosions}
LOW	0 1 rem ≥ dose	0 5 rem ≥ dose	< MODERATE {mitigated fires, spills}

Table 2 also displays a set of qualitative guidelines for assessment of immediate worker consequences Deviations from these guidelines may occur for specific accident scenarios based on the amount of credit taken for mitigative features Actual immediate worker consequence assessments take into account the following considerations

- Timing of Radiological Release – Some accident scenarios, like fires, can develop quickly, but not so quickly as to preclude evacuation as an effective mitigation measure Other scenarios, like criticalities or explosions, can entail significantly more rapid radiological exposure, lessening the impact of evacuation on consequences

- Hazard Warning – The availability of a reliable hazard warning and the timing of the warning relative to significant radiological exposure may impact immediate worker consequences Warning may be provided by engineered systems (*e g*, fire alarms, warning announcements on the Life Safety/Disaster Warning (LS/DW) system) or by the event itself (*e g*, smoke from a fire, drum lid displacement)

- Scenario Impact on Protective Action Capability – Accident scenarios involving energetic events, like explosions, can cause damage to structures or injury to personnel The structural damage and/or personnel injury can impede immediate worker egress, thus, increasing potential radiological consequences

- Appropriate Focus for Preventive or Mitigative Measures – The only effective measures to protect the immediate worker for some accident scenarios, like criticalities, may be preventive However, other workers in the facility may be aided by mitigative measures Consequences to the attending worker in such an instance may not be a useful test of the adequacy of proposed mitigative measures

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- Potential Exposure Magnitude and Exposure Pathway – The severity of radiological injury is a function of the magnitude of the accident scenario release and the pathways for transport to and absorption by workers Inhalation is typically the dominant exposure pathway

- Consequence Uncertainty for the Immediate Worker – The radiological thresholds for prompt death and serious injury vary among individuals and are stochastic effects In a quantitative immediate worker consequence evaluation, any defined radiological thresholds would have to be compared to localized radiological doses that are difficult to calculate and are beyond the scope of this effort Thus, a qualitative evaluation of immediate worker consequences is implemented and the methodology employs conservatism When the qualitative evaluation conservatism is combined with the effectiveness of imposed controls, the actual immediate worker protection may be more effective than a quantitative radiological threshold and evaluation would require

Radiological doses for the MOI and CW are calculated using the *Radiological Dose Template* (Ref 12)

3.2.2 Chemical And Other Hazardous Material Risk

Toxicological consequence evaluations for postulated accident scenarios involving chemicals and other hazardous materials are determined using a combination of qualitative and quantitative evaluation techniques as discussed below The receptors identified for analysis are (1) the MOI, (2) the CW, and (3) the IW The definition and location of the receptors of interest are the same as for the radiological consequence evaluations discussed in Section 3 2 1, *Radiological Risk*

Hazardous materials can exist throughout a facility and may be in various forms In support of the determination of hazardous material risks, hazardous material inventories are defined in four general categories (1) hazardous materials in waste, (2) process chemicals, (3) bulk or product chemicals, and (4) in situ hazardous materials

The hazardous materials in waste category includes Resource Conservation and Recovery Act (RCRA) containerized wastes, Toxic Substances Control Act (TSCA) containerized wastes, and non-RCRA / non-TSCA hazardous material containerized waste The containers utilized for holding hazardous materials include, in part, 55-gallon drums, metal standard waste boxes, and wooden waste crates The hazardous materials, in many cases, may be located in the same containers as radioactive materials Information regarding containerized waste may be obtained from the Site-wide Waste and Environmental Management System (WEMS) database or equivalent facility databases These databases contain characterization information for each waste container including waste type, container type, Item Description Code (IDC) or Waste Form code (WFC) designation, assigned Environmental Protection Agency (EPA) waste codes, and waste compatibility codes

The process chemicals category includes chemicals that have been introduced into processes that were suspended or never activated or have been introduced into current operating processes Any chemical holdup in solution piping is included in this category Process chemicals, in some cases, may contain radioactive materials Information about process chemicals is generally determined by interviews with facility personnel

The product or bulk chemical category includes chemicals that are planned for use and are currently being stored in the facility Bulk chemicals are not contaminated with radioactive materials Information about bulk chemicals may be obtained from the Site-wide Integrated Chemical Management System (ICMS) database or equivalent facility databases

The in situ hazardous materials category includes hazardous materials that exist in the facility as part of structure (*e g*, lead-base paints located on walls and floors, asbestos containing ceiling panels, floor tiles, or walls, polychlorinated-biphenyl (PCB) containing equipment like fluorescent lighting or transformers). In general, in situ hazardous materials are fixed in place and, in some cases, may be contaminated with radioactive materials

Hazardous chemicals and other materials in the facility that are identified as being in one of the four hazardous material categories are screened against (1) the Threshold Planning Quantity (TPQ) values listed in *List of Regulated Substances and Thresholds for Accidental Release Prevention*, 40 CFR 355 (Ref 13), (2) the Threshold Quantity (TQ) values listed in *Process Safety Management (PSM) of Highly Hazardous Chemicals*, 29 CFR 1910 119, (Ref 14) and *Risk Management Programs for Chemical Accidental Release Prevention*, 40 CFR 68, (Ref 15), and (3) the Reportable Quantity (RQ) values listed in *List of Hazardous Substances and Reportable Quantities*, 40 CFR 302 (Ref 16) Hazardous materials of interest that may be found on the Site are listed in Appendix D of the SARAH (Ref 8) along with TPQ, TQ, and RQ values If the quantity of the hazardous material in the facility is below TPQ, TQ, and RQ values, the material does not require further evaluation

For hazardous materials that do not have TPQ or TQ values but have RQ values and the quantity of material in the facility exceeds the RQ value, qualitative arguments dealing with dispersibility and programmatic controls associated with the hazard are used to complete the hazard evaluation These types of hazardous materials, in general, only pose threats to the IW and/or the environment and not to the CW or the public

For hazardous materials with facility quantities in excess of specified TPQ or TQ values, a quantitative evaluation of accidental releases of the material is performed Determinations are made of chemical concentrations at the CW and MOI receptor locations using Site-accepted chemical dispersion modeling tools as identified in the SARAH (Ref 8)

For immediate worker consequences, a qualitative judgment of acute toxicological effects is made Scenario related effects (*e g*, burns from fires, injuries from energetic events) are discussed in the accident scenario summaries but are not included in the determination of the scenario risk class

Toxicological consequences corresponding to the High, Moderate, and Low consequence bins identified in Table 1 are defined by the comparison criteria developed in DOE-STD-3011-94 and shown in Table 3 Toxicological consequence bin thresholds for the MOI and CW are defined in terms of *Emergency Response Planning Guideline* (ERPG) values, published by the American Industrial Hygiene Association (Ref 17) These guidelines include a set of three numbers (ERPG-1, ERPG-2, and ERPG-3) that quantify the air concentrations for each chemical, corresponding to *low, moderate,* and *severe* health effects in humans exposed to the chemical concentration for up to one hour The "up to one hour" guideline in the definition of ERPGs is interpreted to mean "peak 15-minute average" by the Energy Facility Contractors Group (EFCOG) Non-radiological Hazardous Materials Safety Analysis Subgroup Concentrations of the various chemicals are calculated at the receptor locations and compared to the assigned ERPG values (or alternative values) in order to determine a consequence bin assignment in accordance with Table 3 The *Toxic Chemical Hazard Classification and Risk Acceptance Guidelines for Use in DOE Facilities* (Ref 18) discusses alternative standards for cases where no ERPG value has been assigned As stated above, toxicological consequences for the IW are determined qualitatively, therefore, the toxicological consequence bin thresholds for the IW are defined qualitatively

Table 3 Chemical Toxicological Consequence Bin Thresholds

CONSEQUENCE	MOI CONCENTRATION CONSEQUENCE BIN THRESHOLD	CW CONCENTRATION CONSEQUENCE BIN THRESHOLD	IW CONSEQUENCE
HIGH	concentration > ERPG-2	concentration > ERPG-3	prompt death
MODERATE	not applicable	not applicable	serious injury
LOW	concentration ≤ ERPG-2	concentration ≤ ERPG-3	< MODERATE

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4. HAZARD ANALYSIS

4.1 HAZARD IDENTIFICATION AND DESCRIPTION

This section identifies the radioactive materials and other hazardous materials present in the Building 991 Complex as well as identifying hazards and energy sources that may contribute to a radiological or toxicological release Initial hazard identification for the complex was accomplished by reviewing radiological and other hazardous material inventories currently in the facilities, by interviewing facility personnel for additional hazardous materials that may be present during the conduct of Building 991 Complex activities, and by performing facility walkdown inspections

A standardized general hazard checklist presented in the SARAH was used during the walkdown to identify the general hazard categories present in the Building 991 Complex The SARAH describes the checklist and its application. The hazards specific to the Building 991 Complex are identified in the general hazard checklist shown in Table 4 Of the 13 hazard categories appearing on the general checklist, 11 hazards were found to be present in the Building 991 Complex

The general hazards identified in Table 4 are summarized in more detail in Table 8 The hazard description in the table and the corresponding text provides sufficient detail to justify the classification of identified hazards as Standard Industrial Hazards (*i e*, hazards that only lead to occupational injuries or illnesses and that have limited impact on postulated accident initiation frequency, accident mitigation, and accident consequences) Standard Industrial Hazards are considered to be sufficiently controlled by the set of SMP elements listed in Chapter 3, *Safety Management Programs*, of the FSAR and are not analyzed further Hazards that have not been classified as Standard Industrial Hazards are carried forward into the Safety Analysis

Table 4 Facility General Hazard Identification Checklist

HAZARD	HAZARD DEFINITION	YES/NO
1 High Voltage	Electrical systems or components that have voltages greater than 600 V, including AC electric power distribution systems from Site power	Yes
2 Explosive Substances	Explosive devices or chemicals that are being prepared or used in explosive devices (*e g*, blasting caps, squibs, dynamite) as designated in 49 CFR 173 50 (Ref 19), does not include potentially explosive gases or chemicals	No
3 Direct Radiation Sources	Sources that produce ionizing radiation at a known level (*e g*, X-ray machines, accelerators, sealed sources)	Yes
4 Radioactive Materials	Radioactive materials that are dispersible (*i e* require low energy for release), does not include sealed sources or nontransferable contamination	Yes
5 Thermal Energy	Hazards that are capable of producing burns, starting fires, causing undesired chemical reactions, or producing hazardous vapors, including hot surfaces	Yes

Table 4 Facility General Hazard Identification Checklist

HAZARD	HAZARD DEFINITION	YES/NO
6 Pressure Sources	High-pressure systems (liquid or gas) that are capable of rupturing, producing damaging missiles, or hazardous material dispersal energy, including compressed air used as a facility utility and standard compressed gas bottles	Yes
7 Kinetic Energy	Moving or rotating equipment that is capable of breaching hazardous material containers or producing damaging missiles	Yes
8 Potential Energy	Systems, components, or situations that have stored energy, including chemical systems (e g, large battery banks), electrical systems (e g, large capacitor banks), or mechanical systems or situations (e g, large elevated masses, raised waste containers)	Yes
9 Hazardous Chemicals or Materials	Chemicals or materials that are considered toxic, noxious, or otherwise hazardous (e g RCRA listed, TSCA listed)	Yes
10 Inadequate Ventilation	Areas or rooms that are susceptible to low or inadequate ventilation where flammable gases, hazardous vapors, or asphyxiants may accumulate (e g, confined spaces)	Yes
11 Material Handling	Operations that involve continuous handling of materials (e g, waste container receipt and shipment)	Yes
12 Unknown or Unmarked Materials	Materials or chemicals that are of unknown nature (e g, unmarked containers)	No
13 Other Hazards	Hazard or concern that does not fit into a specific hazard category, (e g, areas with high combustible loading, areas with high levels of contamination, areas particularly susceptible to natural phenomena, shock sensitive chemicals, explosive gases)	Yes

Table 8 lists the eleven general hazards identified in the facility and specifies more detail dealing with each hazard Hazard characterization information dealing with hazard attributes such as description, quantity, form, packaging, and location are provided in the table and further discussed in the corresponding hazard sub-section text

Some hazards are only present for specific activities that are being conducted or specific situations (*e g*, kinetic energy associated with forklifts is only applicable when the forklifts are being used). The table identifies those activities from Section 1 2, *Complex Mission And Activities Overview*, of the FSAR to which a specific hazard may be applicable Applicable activities are defined as activities that can create or interact with specific hazards Acronyms for activity titles that are used throughout the remainder of the Safety Analysis are defined in Table 5 Tables are presented in each hazard discussion sub-section that define the interactions between hazards and activities These tables, at a minimum, identify those activities that (1) operate, use, manipulate, or move the hazard (if applicable), (2) maintain or repair the hazard (if applicable), and (3) inspect or test the hazard (if applicable) Additional interactions are defined as appropriate to specific hazards (*e g*, activities that may indirectly approach a hazard) These tables are intended to present the most likely activity/hazard interactions and are not intended to cover every possible interaction between activities and hazards The information in these tables is based on analyst judgment and it should be expected that a different analyst would indicate different interactions, however, the differences are not expected to be significant Two levels of interaction are identified Definite activity interaction with a hazard will be indicated

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by a "yes" in the table, and possible activity interaction will be indicated by a "may" in the table In either case, Table 8 will indicate the activity in the "Interact Activities" column for hazards considered to be Standard Industrial Hazards For hazards that are carried forward in the Safety Analysis, the entry under the "Interact Activities" column of Table 8 is ADB (Analyzed in Detail Below)

Table 5 Acronyms for the Building 991 Complex Activities

ACRONYM/CODE	SECTION	ACTIVITY TITLE
CHEM / E	1 2 1	Characterization, Treatment, and Disposition of Excess Chemicals
CON / F	1 2 2	Construction
GEN / A	1 2 3	Waste Generation
MAINT / G	1 2 4	Maintenance
SNM / B	1 2 5	Receipt, Staging, and Shipment of Special Nuclear Material
WASTE / C	1 2 6	Receipt, Storage, Transfer, and Shipment of Waste
RA / H	1 2 7	Routine Activities
SURV / D	1 2 8	Surveillance

Two general classes of hazards may exist in the Building 991 Complex· (1) dispersible hazards (*e g*, radioactive material, hazardous chemicals) that must be contained or confined to protect receptors, and (2) hazards that can potentially act on the containment or confinement of other hazards (*e g*, moving equipment, combustibles) The hazardous components of non-dispersible hazards that can impact the IW (*e g*, high voltage electricity, moving equipment) but cannot impact the CW or the public are considered to be addressed by Site programs and are not the focus of the hazard evaluation process This hazard evaluation process presumes that hazardous, dispersible materials are contained in packages that may be susceptible to breach by mechanical, chemical, or thermal means The process also presumes that the dominant dispersible hazards deal with radioactive materials and will only address chemical hazards in cases where significant quantities, relative to specified TQs or TPQs, are available for release

Table 8 and the explanatory text identify a set of candidate general protective features that can be used to reduce the risk associated with the specified hazard for those hazards that are determined to be Standard Industrial Hazards The approach used in the determination of protective features associated with a hazard focuses on how the hazard potentially interacts mechanically, chemically, or thermally with the containment or confinement barriers for hazardous materials in the Building 991 Complex In addition, a set of worker safety protective features is identified for each hazard characterized as a Standard Industrial Hazard, which will not be further evaluated For IW safety, three levels of protection are always addressed, even if no protection exists for the level (1) physical barriers around or dealing with the hazard that can protect the worker (*e g*, fences, shielding), (2) general classes of protective equipment for the

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worker (e g , protective clothing, breathing devices), and (3) administrative imposed requirements to protect the worker (e g , postings, lockout/tagout) The set of protective features for IW protection is not intended to be a complete listing Rather, protective features covering those aspects of the hazard that are considered to place the IW at most risk are listed

Each of the specified features that is credited in making the determination that the hazard is a Standard Industrial Hazard will have a corresponding Site program from Chapter 3, *Safety Management Programs*, of the FSAR identified as the credited program Acronyms corresponding to Site programs that are used in the following tables are defined in Table 6 For hazards that are carried forward in the Safety Analysis, the entry under the "Credited Protective Features" column of Table 8 is ADB (Analyzed in Detail Below)

Table 6 Acronyms for the Site Safety Management Programs

ACRONYM	FSAR SECTION	SAFETY MANAGEMENT PROGRAM TITLE
ORG	3 3	Organization and Management
CONFIG	3 4	Configuration Management
CRIT	3 5	Criticality Safety
ER	3 6	Emergency Response
EPWM	3 7	Environmental Protection and Waste Management
FIRE	3 8	Fire Protection
S&IH	3 9	Safety and Industrial Hygiene
MAINT	3 10	Maintenance
NUC	3 11	Nuclear Safety
OR	3 12	Occurrence Reporting
QA	3 13	Quality Assurance
RAD	3 14	Radiation Protection
RMDC	3 15	Records Management and Document Control
TRAIN	3 16	Training
TRANS	3 17	Transportation
WORK	3 18	Work Control

An indication of the general types of accident scenarios associated with Non-Standard Industrial Hazards is provided in the "Remarks" column of Table 8 For each hazard that is to be carried forward in the Safety Analysis, potential accident scenarios involving the hazard or caused by the hazard are identified Seven general types of accident scenarios are used to characterize the spectrum of analyzed events The seven accident scenario types are listed and defined in Table 7 The table addresses the accident types in terms of events involving radioactive materials but the general accident scenario types could also be applied to other hazardous materials (*e g*, chemicals)

Table 7 General Types of Accident Scenarios in Safety Analysis

SCENARIO TYPE	GENERAL ACCIDENT SCENARIO DESCRIPTION
Material Fire	This accident scenario type is used to cover fires caused by pyrophoric radioactive material exposures to air (*i e*, container breach) The Building 991 Complex will handle containers containing pyrophoric radioactive metals as part of the SNM activity and potentially as part of the WASTE activity and as required to support the conduct of the CHEM, CON, MAINT, and SURV activities (*e g*, movement of containers prior to performing work) This type of fire is distinguished from the "Facility Fire" scenario type due to the initiating event mechanism differences (*i e*, more spill-like than fire-like)
Facility Fire	This accident scenario type is used to address fires occurring within the Building 991 Complex that can be caused or exacerbated by the conduct of the CHEM, CON, MAINT, and RA activities (*e g*, mixing incompatible chemicals, errors while performing hot work, introduction of combustible material) or can occur during the conduct of radioactive material receipt and shipment under the GEN, SNM, and WASTE activities (*i e*, use of transport vehicles containing fuel)
Spill	This accident scenario type is used to cover spills of confined radioactive material as the result of radioactive material container drops during the handling of the containers under the conduct of the GEN, SNM, and WASTE activities, as required to support the conduct of the CHEM, CON, MAINT, and SURV activities (*e g*, movement of materials prior to performing work), and due to inadvertent contact with containers during the conduct of the CON, MAINT, SNM, and RA activities (*e g*, vehicle contact with containers during movement of "non-hazardous" materials for construction)
Puncture	This accident scenario type is used to cover punctures of containers containing radioactive material as the result of radioactive material container contact with forklift tines during the handling of the containers under the conduct of the GEN, SNM, and WASTE activities, as required to support the conduct of the CHEM, CON, MAINT, and SURV activities (*e g*, movement of materials by forklift prior to performing work), and due to inadvertent contact with containers during the conduct of the CON, MAINT, SNM, and RA activities (*e g*, forklift contact with containers during movement of "non-hazardous" materials for construction) This type of spill is distinguished from the "Spill" scenario type to draw attention to the spill resistance of the Type B shipping and the POC versus the Type B shipping and the POC susceptibility to puncture events
Container Explosion	This accident scenario type is used to cover waste container hydrogen explosions as a result of the handling of the containers under the conduct of the WASTE activity, as required to support the conduct of the CHEM, CON, MAINT, and SURV activities (*e g*, movement of containers prior to performing work), and due to inadvertent contact with containers during the conduct of the CON, GEN, MAINT, SNM, and RA activities (*e g*, vehicle contact with containers during movement of "non-hazardous" materials for construction) This type of explosion is distinguished from the "Facility Explosion" scenario type due to the initiating event mechanism differences (*i e*, container movement can lead to container explosion where the introduction of flammable gas is needed for facility explosion)

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Table 7 General Types of Accident Scenarios in Safety Analysis

SCENARIO TYPE	GENERAL ACCIDENT SCENARIO DESCRIPTION
Facility Explosion	This accident scenario type is used to address explosions occurring within the Building 991 Complex that can be caused by the conduct of the CON and MAINT activities (*e g*, errors while using propane) and can impact radioactive material containers associated with the GEN, SNM, and WASTE activities
Criticality	This accident scenario type is used to cover radioactive material criticalities as a result of the rearrangement of containers under the conduct of the SNM and WASTE activities, as required to support the conduct of the CHEM, CON, MAINT, RA, and SURV activities (*e g*, movement of containers prior to performing work), and as a result of other accident scenarios initiated by any of the activities

Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
1 HIGH VOLTAGE							
A 13 8kV Transformers	Two	Standard transformers for converting Site power (13 8kV) to facility power (480V)	Fenced enclosure	East side of Complex	CON, MAINT, RA, SURV	• Current configuration control • Combustible control IW PROTECTION • Fenced area, insulated enclosure • Insulated clothing & equipment • Work control, postings, training, lockout/tagout	**Standard Industrial Hazard** Transformers located away from any waste storage locations, No identified mechanism for interaction with radioactive materials Credited SMPs CONFIG, FIRE, S&IH, TRAIN, and WORK Lower voltage electric power is considered in Safety Analysis as fire initiators (see THERMAL ENERGY)
3 DIRECT RADIATION SOURCES							
A Sealed Sources	See Table 11	Site standard instrument calibration sources	Site standard sealed source packaging	Vault 996, Room 150 vault, Room 170 dock, Room 132	RA, SURV	• Source package IW PROTECTION • Shielding • Dosimetry, leaded clothing • Source inspection, source package quality, postings, work control, ALARA, training, source use evaluation, source control	**Standard Industrial Hazard** Used for instrument calibration, Sealed sources, while containing radioactive material, pose no risk to CW or public due to packaging Credited SMPs ORG, S&IH, MAINT, QA, RAD, TRAIN, and WORK
B X-ray Device	One	Portable iridium-192 source	Shielded containment	Room 164	RA, SURV	• Current configuration control IW PROTECTION • Device, device shielding • Dosimetry • Device inspection, postings, work control, training, device control	**Standard Industrial Hazard** Used for Non Destructive Testing (NDT), X-ray device, while producing radiation, poses no risk to CW or public due to separation distances Credited SMPs ORG, CONFIG, S&IH, RAD, TRAIN, and WORK

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
4 RADIOACTIVE MATERIALS							
A Category I and II SNM	Containers with up to the following Weapons Grade Plutonium (WG Pu) Equivalent value 6 kilograms	Uranium, plutonium metals, or plutonium oxides	Approved DOT Type B shipping containers	Room 150 vault	ADB	ADB	Considered in Safety Analysis as radioactive material source for material fire, facility fire, spill, puncture, facility explosion, and criticality events
B Waste Containers	Containers with up to the following WG Pu Equivalent values 0 5 grams 3 grams 200 grams 320 grams 1,255 grams	Plutonium, americium, or uranium contaminated waste	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	Metal containers throughout the complex, Wooden containers under dock canopy	ADB	ADB	Considered in Safety Analysis as radioactive material source for facility fire, spill, puncture, container explosion, facility explosion, and criticality events
C Contamination	Minimal	Limited radioactive material on HEPA filters, drums to be crushed, or structures	not applicable	Filter plenums	CON, GEN, MAINT, SNM, WASTE, RA, SURV	• No container opening <u>IW PROTECTION</u> • Confinements • Dosimetry, respiratory protection, contamination protection clothing • Maintenance work evaluation, area surveys, radiation work permits, work control, postings, ALARA, training	**Standard Industrial Hazard** Levels of contamination have been negligible on removed HEPA filters but filters treated as LLW, No risk posed to the CW or the public from contamination Credited SMPs EPWM, MAINT, RAD, TRAIN, and WORK

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
5 THERMAL ENERGY							
A Heated Water	not applicable	Water at <201°F	Insulated steel piping	Throughout complex for heating	CON, MAINT, RA, SURV	• Current configuration control IW PROTECTION • Piping, insulation • Non-absorbent thermal protection clothing • System inspection/monitoring, maintenance work evaluation, work control, labeling, training	**Standard Industrial Hazard** No potential for initiation of fires, No risk posed to the CW or the public, IW risk only Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
B Propane	Limited quantities in single container, Larger quantities in storage tanks	Propane gas used for some maintenance activities, Storage tanks above and near complex	Limited capacity gas cylinders, Large capacity steel tanks	Throughout complex as permitted, On elevated terrain west of the Building 991 Complex	ADB	ADB	Considered in Safety Analysis as material fire, facility fire, facility explosion, and criticality initiators / precursors
C Natural Gas	not applicable	Natural gas used for complex heating boilers	Steel piping	East of Building 991 and in boiler building	ADB	ADB	Considered in Safety Analysis as material fire, facility fire, facility explosion, and criticality initiators / precursors
D Pyrophoric Materials	Up to 6 kilograms in a single container	Uranium or plutonium metal parts and uranium fines	Approved DOT Type B shipping containers and a 10-gal drum	Room 150 vault, Vault 996	ADB	ADB	Considered in Safety Analysis as a material fire initiator / precursor (uranium fines in 10-gal drum in Vault 996 is no longer in facility but analysis still evaluates the hazard)
E Electric Power System	From 480 V to 110 V system	Wiring, switchgear, motors	not applicable	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, facility fire, facility explosion, and criticality initiators / precursors

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
5 THERMAL ENERGY (continued)							
F Electric Heaters	Six	Moderate size room heaters	not applicable	Room 166 ceiling (3), Room 167 (1), Building 989 (2)	MAINT, RA, SURV	• System maintenance • Current configuration control • Combustible control IW PROTECTION • Elevation, heater enclosures • Thermal protection & insulated clothing • System inspection/monitoring, maintenance work evaluation, work control, postings, training, lockout/tagout	**Standard Industrial Hazard** Due to the heater location at the ceiling of Room 166, Room 166 heaters not considered to be a significant fire initiator, electric power system fire initiators considered to bound heater risk, No radioactive material releases associated with Room 167 and Building 989 fires, No risk posed to the CW and the public beyond that posed by loss of power events Credited SMPs ORG, CONFIG, EPWM, FIRE, S&IH, MAINT, TRAIN and WORK
G Diesel Generator, Day Tank, Batteries	One	A 256kW generator, diesel engine, 180-gallon diesel fuel oil day tank, starting batteries	not applicable	Building 989	MAINT, RA, SURV	• System maintenance • Current configuration control • Combustible control IW PROTECTION • Separate & locked facility • Thermal protection & insulated clothing • System inspection/monitoring, maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** No radioactive material releases associated with Building 989 fires, No risk posed to the CW and the public beyond that posed by loss of power events, IW risk only Credited SMPs ORG, CONFIG, EPWM, FIRE, S&IH, MAINT, TRAIN, and WORK
H Transport Vehicles	Up to two at one dock	Standard diesel-fueled trucks and cargo trailers	not applicable	East Dock, West Dock	ADB	ADB	Considered in Safety Analysis as a facility fire initiator / precursor

Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
6 PRESSURE SOURCES							
A Compressed Air, Compressors	Three compressors	Compressors up to 130 psi Air systems up to 90 psi normal operating pressure One compressor out-of-service	Piping and compressors	Room 130, Building 985	CON, MAINT, RA, SURV	• Current configuration control IW PROTECTION • Piping, components, relief valves • Eye shields • System inspection/monitoring, maintenance work evaluation, work control, labeling, training, lockout/tagout	**Standard Industrial Hazard** No radioactive material release associated with air system failures due to relatively low system pressures, radioactive material container strength, and radioactive material proximity, No risk posed to the CW and the public, IW risk only Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
B Drum Crusher	One	Gasoline fuel powered hydraulic crusher	not applicable	Building 984	GEN, MAINT, RA, SURV	• LLW restriction • Current configuration control IW PROTECTION • Component • Eye shields • Component inspection, maintenance work evaluation, work control, training	**Standard Industrial Hazard** Levels of contamination have been negligible on drums to be crushed but output treated as LLW, No risk posed to the CW or the public from contamination Credited SMPs CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
C Pressurized Metal Waste Containers	Many	Sealed containers with radioactive & other materials capable of generating gases	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC	Throughout complex	ADB	ADB	Risks posed by pressurized waste containers are bounded by hydrogen explosion analyses (see OTHER HAZARDS)
7 KINETIC ENERGY							
A Vehicles, Material Handling Equipment	Multiple	Electric forklifts, diesel forklift outside, hand controlled lifts, trucks at dock	not applicable	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, spill, puncture, and criticality initiators / precursors

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
7 KINETIC ENERGY (continued)							
B Rotating Machinery & Tools	Multiple	Fans, pumps, compressors, rotating cutting tools	not applicable	Room 130, Room 137, Room 402, Building 985, tools throughout complex	CON, MAINT, RA, SURV	• Current configuration control, maintenance work evaluation, work control IW PROTECTION • Component enclosures, speed governors • Eye shields, non-loose clothing • System inspection/monitoring, tool inspection, maintenance work evaluation, work control, postings, training, lockout/tagout	**Standard Industrial Hazard** Rotating machinery is not located near any significant quantities of radioactive material and poses no risk to the CW and the public, Tools may be used near radioactive materials but insufficient energy to cause container damage and poses no risk to the CW and the public Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
8 POTENTIAL ENERGY							
A Overhead Cranes	Seven	Rail cranes and fixed cranes with load capacities from 300 lbs to 3 tons	not applicable	Room 134 (3 ton), Room 147, Room 164 & Room 165 (750 lbs), Room 170 (1 ton), Vault 996, East Dock (500 lbs)	MAINT, RA, SURV	• Current configuration control IW PROTECTION • Component inspection/ surveillance, maintenance work evaluation, work control, postings, training, lockout/tagout	**Standard Industrial Hazard** None are in use, except for one crane in Room 164 for NDT work, Load drops from cranes onto waste or SNM containers is not evaluated other than treating the cranes as debris that falls during earthquake events, No risk posed to the CW and the public as long as cranes are not used, IW risk from inspections and Room 164 crane use Credited SMPs CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK

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Table 8 Building 991 Complex Hazard Description Summary

	Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
8	POTENTIAL ENERGY (continued)							
B	Raised Loads on Forklifts	not applicable	When stacking waste containers, containers may be raised as high as fourth tier, Up to four drums on pallet and only one waste box or crate	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, spill, and criticality initiators / precursors
C	Stacked Waste Containers	Many	Waste drums up to four high and waste boxes up to two high	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, spill, and criticality initiators / precursors
9	TOXIC, HAZARDOUS, OR NOXIOUS CHEMICALS							
A	General Industrial Chemicals	See Table 33	Laboratory chemicals, paints, developer fluid, sealers, *etc*	Standard containers drums, vials, bottles, bags, cans, *etc*	Throughout complex	CHEM, CON, MAINT, RA, SURV	• Chemical package • Quantity control • Current configuration control <u>IW PROTECTION</u> • Protective clothing, eyewash & safety showers, respirators • Chemical inventory, area restrictions, area surveys, maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** Chemical inventories are below evaluation thresholds and pose no risk to the CW and the public, IW risk only Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
9 TOXIC, HAZARDOUS, OR NOXIOUS CHEMICALS (continued)							
B Cupric Chloride Dihydrate	Approximately 28 pounds in five containers	Chemical exceeding RQ threshold of 10 pounds	Standard chemical container	Room 109, Room 110	CHEM, RA, SURV	• Chemical package • Quantity control • Current configuration control IW PROTECTION • Protective clothing, eyewash & safety showers • Chemical inventory, area surveys, work control, postings, training	**Standard Industrial Hazard** Chemical inventory exceeds RQ threshold of 10 pounds but is contained in five separate containers, each of which is below the RQ threshold, No risk posed to the CW and the public (no TQ or TPQ defined or exceeded), IW risk only Credited SMPs ORG, CONFIG, EPWM S&IH TRAIN, and WORK
C Beryllium	Multiple	Parts	Approved on-site shipping containers, 55-gal drum	Room 158	WASTE, SURV	• Current material form control	**Standard Industrial Hazard** Beryllium parts located in identified and classified waste containers, No risk posed to the IW, the CW, and the public due to form of material Credited SMPs EPWM, and S&IH
D Asbestos	Varies	Potentially located in ceiling tiles, floor tiles, and walls, waste containers	not applicable, approved on-site shipping containers, 55-gal drum, SWB, metal waste box	Throughout complex, tiled area in basement	CON, GEN, MAINT, RA, SURV	• Current configuration control, waste containers IW PROTECTION • Protective clothing, respirators • Area restrictions, area surveys, maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** Asbestos abatement is relied upon to mitigate the consequences to the IW of the hazard, No risk posed to the CW and the public Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK

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Table 8 Building 991 Complex Hazard Description Summary

	Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
9	**TOXIC, HAZARDOUS, OR NOXIOUS CHEMICALS** (continued)							
E	Polychlorinated Biphenyls (PCBs)	Various	Transformer fluids, lighting ballasts	Transformer and lighting ballasts	Transformers in Room 130 & outside, east of Building 991, throughout complex	CHEM, CON, GEN, MAINT RA, SURV	• Current configuration control, waste containers IW PROTECTION • Protective clothing • Maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** Chemical control and TSCA waste management programs are relied upon to mitigate the consequences to the IW of the hazard, No risk posed to the CW and the public Credited SMPs CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
F	Lead	Various	Batteries, paints, sealant	not applicable	Throughout complex, Sealant in Room 130	CHEM, CON, GEN, MAINT RA, SURV	• Current configuration control, waste containers IW PROTECTION • Protective clothing • Area restrictions, area surveys, maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** Chemical control and RCRA waste management programs are relied upon to mitigate the consequences to the IW of the hazard, No risk posed to the CW and the public Credited SMPs ORG, CONFIG, EPWM, S&IH, MAINT, TRAIN, and WORK
G	Batteries	Multiple	Lead acid 48 volt batteries for diesel support, nickel-cadmium batteries for tenant activities, standard emergency lighting and panel batteries	not applicable	Building 989, Room 106, throughout complex	CON, GEN, MAINT, SNM, WASTE, RA, SURV	• Component package IW PROTECTION • Protective clothing, eyewash & safety showers • Component inspections, work control, training	**Standard Industrial Hazard** Waste management programs are relied upon to mitigate the consequences to the IW of the hazard, No risk posed to the CW and the public Credited SMPs EPWM, S&IH, TRAIN and WORK

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
9 TOXIC, HAZARDOUS, OR NOXIOUS CHEMICALS (continued)							
H Diesel Fuel (Gasoline)	Three tanks	A 180-gallon day tank and a 1,000-gallon, above-ground, fiberglass tank, Gasoline fuel tank for drum crusher motor	tanks	Day tank in Building 989, Large tank East of Building 989, Building 984	MAINT, RA, SURV	• Storage tanks <u>IW PROTECTION</u> • Chemical inventory, work control, training	**Standard Industrial Hazard** Health and safety programs are relied upon to mitigate the consequences to the IW of the hazard, Fire safety programs are relied upon to control the fire hazard (see THERMAL ENERGY and OTHER HAZARDS), No risk posed to the CW and the public Credited SMPs S&IH, TRAIN, and WORK
10 INADEQUATE VENTILATION							
A Unventilated Tunnels and Areas	Three	Following loss of ventilation, tunnels and the basement <u>may</u> become confined spaces	not applicable	Corridor B & connecting tunnels / vaults, Corridor A & connecting vault, Basement	CON, GEN, MAINT, WASTE, RA, SURV	• Area surveys/monitoring • Current configuration control <u>IW PROTECTION</u> • Locked doors • Breathing air • Area restrictions, area surveys, work control, postings, training	**Standard Industrial Hazard** Health and safety programs are relied upon to mitigate the consequences to the IW of the hazard, No risk posed to the CW and the public Credited SMPs ORG, CONFIG, EPWM, S&IH, TRAIN, and WORK
11 MATERIAL HANDLING							
A Receipt and Shipment of Waste Containers at the Dock	Multiple	Removing/ loading waste containers from/on transport vehicles, moving waste containers between dock and storage location	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	East dock, West dock	ADB	ADB	Considered in Safety Analysis as material fire, puncture, and criticality initiators / precursors

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
11 MATERIAL HANDLING (continued)							
B Receipt and Shipment of SNM Containers at the Dock	Multiple	Removing/ loading SNM containers from/on transport vehicles, moving SNM containers between dock and storage location	Approved DOT Type B shipping containers	Room 150 vault, West dock	ADB	ADB	Considered in Safety Analysis as material fire, puncture, and criticality initiators / precursors
C Movement of Waste Containers in the Facility	Multiple	Moving waste containers within the facility for inspections, as a result of activity interactions, due to waste container generation, or removal of specific containers	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, puncture, and criticality initiators / precursors
13 OTHER HAZARDS							
A Hydrogen Generation in Metal Waste Containers	Many	Sealed containers with radioactive & other materials capable of generating hydrogen	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC	Throughout complex	ADB	ADB	Considered in Safety Analysis as a container explosion initiator / precursor

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
13 OTHER HAZARDS (continued)							
B Battery Charging Station	Two	Several battery chargers for forklift batteries	not applicable	Room 136, Corridor B	CON, GEN, MAINT, SNM, WASTE, RA, SURV	• Current configuration control • Combustible control IW PROTECTION • Component enclosure • Protective clothing, eye shields • Component inspections, work control, postings, training, lockout/tagout	**Standard Industrial Hazard** Charging station is located in an area without radioactive material storage, Explosions or fires from chargers or batteries is isolated from waste containers by interior walls, No risk posed to the CW or the public Credited SMPs CONFIG, EPWM FIRE, S&IH, TRAIN, and WORK
C Tunnel Degradation and Leakage	Two	Cracks in tunnel wall with ground water in-leakage and potential structural degradation	not applicable	Corridor C, Corridor A	ADB	ADB	Considered in Safety Analysis as material fire, spill, puncture, and criticality initiators / precursors
D Diesel Fuel (Gasoline) Storage Tank Combustibles	Three tanks	A 180-gallon day tank and a 1,000-gallon, above-ground, fiberglass tank, Gasoline fuel tank associated with drum crusher motor	tanks	Day tank in Building 989, Large tank East of Building 989, Building 984	GEN, MAINT, RA, SURV	• System maintenance • Current configuration control • Hot work control IW PROTECTION • Separate facility, locked facility • System inspection/monitoring, maintenance work evaluation, work control, postings, training	**Standard Industrial Hazard** Diesel fuel is located in areas without radioactive material storage, Fires from diesel fuel are isolated from waste containers by exterior walls, No risk posed to the CW or the public Credited SMPs ORG, CONFIG, EPWM, FIRE, S&IH, MAINT, TRAIN, and WORK
E Floor Loading	Multiple	Stacked waste storage areas over basement open areas	not applicable	Waste storage locations with three or more tiers of waste containers	ADB	ADB	Considered in Safety Analysis as material fire, spill, and criticality initiators / precursors

Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
13 OTHER HAZARDS (continued)							
F Combustibles	Varies	Wooden pallets, Office Area combustibles, wooden waste crates, miscellaneous flammable chemicals	Flammable chemicals in flammable liquid storage cabinets, not applicable for other combustibles	Chemical storage cabinets in Room 109, Room 155, Room 164, Room 165, Room 167, East Dock, Wooden pallets and crates in Room 170, Dock areas, Office area	ADB	ADB	Combustibles or various types may exist at times within the complex, Considered in Safety Analysis as a facility fire initiator / precursor and propagator
G Natural Phenomena or External Event Induced Fires	not applicable	Seismic events, Lightning, Aircraft crash, Range fires	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	Throughout complex	ADB	ADB	Considered in Safety Analysis as a facility fire initiator / precursor
H Natural Phenomena or External Event Induced Spills	not applicable	Seismic events, High winds, Tornadoes, Heavy rain, Flooding, Heavy snow, Freezing, Aircraft crash	Approved DOT Type B shipping containers, Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	Throughout complex	ADB	ADB	Considered in Safety Analysis as material fire, spill, puncture, and criticality initiators / precursors

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Table 8 Building 991 Complex Hazard Description Summary

Hazard / Energy Source	Quantity on Hand	Form / Description	Packaging	Location	Interact Activities	Protective Features for Standard Industrial Hazards	Remarks
13 OTHER HAZARDS (continued)							
I Natural Phenomena or External Event Induced Explosions	not applicable	Seismic events, High winds, Tornadoes, Heavy snow, Lightning, Aircraft crash	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC, wooden waste crate	Throughout complex	ADB	ADB	Considered in Safety Analysis as a material fire, facility explosion, and criticality initiators / precursors (seismic events, high winds, tornadoes, and heavy snow can potentially impact natural gas line / boiler leading to explosion)
J Natural Phenomena or External Event Induced Criticalities	not applicable	Seismic events, Heavy rain, Heavy Snow, Flooding, Freezing, Aircraft crash	Approved on-site shipping containers, 55-gal drum, SWB, metal waste box, POC	Throughout complex	ADB	ADB	Considered in Safety Analysis as a criticality initiator / precursor

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4.1.1 High Voltage (Hazard/Energy Source 1)

13 8kV Transformers (Sub-hazard 1A)

Two 13 8 kV to 480 V transformers are located on the outside of Building 991 in an area east of the facility The transformers present a significant electrical hazard that potentially can initiate fires and electrocute personnel The transformer area is generally cleared but grasses (*i e*, potential for external event range fire) are located near the transformer enclosure No radioactive materials are located close enough to the transformers to be impacted by transformer-related hazards and, therefore, the hazard associated with the transformers is considered a **Standard Industrial Hazard** and will not be further evaluated However, low voltage electric power systems are located in areas containing radioactive material and are potential fire initiators (see Section 4 1 4) Interactions of the hazard with activities are shown in Table 9

Table 9 13.8 kV Transformer Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	
Maintains/Repairs				yes				
Inspects/Tests								may
Indirectly Approaches/Nears		may		may			may	may

Protective features credited in the determination that the 13 8 kV transformers are a Standard Industrial Hazard are shown in Table 10

Table 10 13.8 kV Transformers Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal and Electrical Interaction	yes	Separation from hazardous materials Separation from combustibles	Current configuration control [CONFIG] Combustible control [FIRE]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Fenced area, insulated enclosure [S&IH] Insulated clothing, insulated equipment [S&IH] Work control, postings, training, lockout/tagout [WORK, S&IH TRAIN]

4.1.2 Direct Radiation Sources (Hazard/Energy Source 3)

Sealed Sources (Sub-hazard 3A)

Sealed sources are identified in Table 11 and are radioactive material sources stored within source lockers and vaults in the complex The sources present a radiation hazard that potentially can yield significant personnel radiation exposures The sources, in most cases, contain relatively small amounts of radioactive material However, there are multiple sources with non-trivial quantities of radioactive material The Curie quantities shown in the table come from source information, the gram quantities are derived using gram-per-Curie ratios developed from DOE-STD-1027-92 (Ref 3) Even though some sources contain non-trivial quantities of radioactive material, the sources are considered a **Standard Industrial Hazard** due to the rigor associated with source packaging These hazards will not be further evaluated Interactions of the hazard with activities are shown in Table 12

Table 11 Radioactive Sources

NUCLIDE	REGISTRY #	LOCATION	PRESENT AMOUNT g (1)	PRESENT ACTIVITY µCi (1)
^{235}U	AS-518	Room 170	11	2 30E+01
^{133}Ba	AS-553	Room 170	2 0E-08	4 91E+00
^{133}Ba	AS-554	Room 170	2 0E-08	4 89E+00
^{133}Ba	AS-966	Room 170	3 6E-08	9 00E+00
^{133}Ba	AS-967	Room 170	3 6E-08	9 06E+00
^{133}Ba	AS-968	Room 170	5 1E-08	1 28E+01
^{133}Ba	AS-969	Room 170	5 3E-08	1 32E+01
^{133}Ba	AS-970	Room 170	9 6E-08	2 40E+01
^{133}Ba	AS-971	Room 170	9 6E-08	2 41E+01
^{133}Ba	AS-972	Room 170	1 0E-07	2 58E+01
^{133}Ba	AS-973	Room 170	1 3E-07	3 13E+01
^{133}Ba	TS-1687	Room 170	7 9E-09	1 97E+00
^{133}Ba	TS-1688	Room 170	8 6E-09	2 16E+00
^{133}Ba	AS-1689	Room 170	2 0E-08	5 06E+00
^{133}Ba	TS-1690	Room 170	6 6E-09	1 66E+00
^{133}Ba	AS-1691	Room 170	1 4E-08	3 45E+00
^{133}Ba	AS-1692	Room 170	2 1E-08	5 24E+00
^{137}Cs	AS-1694	Room 170	1 1E-07	9 41E+00
^{137}Cs	AS-839	Room 160	9 6E-07	8 32E+01
^{192}Ir	TS-943	Room 164	5 4E-14	5 00E-04
^{238}Pu	AS-5	Room 150	4 4E-03	7 50E+04
^{239}Pu	AS-14	Room 150	97	6 00E+06
^{252}Cf	AS-482	Room 150	2 7E-07	1 44E+02
^{252}Cf	AS-483	Room 150	2 7E-07	1 44E+02
^{252}Cf	AS-603	Room 150	3 5E-11	1 88E-02
^{252}Cf	AS-629	Room 150	4 9E-09	2 64E+00

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Table 11 Radioactive Sources

NUCLIDE	REGISTRY #	LOCATION	PRESENT AMOUNT g (1)	PRESENT ACTIVITY μCi (1)
^{252}Cf	AS-632	Room 150	4 9E-09	2 64E+00
^{252}Cf	AS-636	Room 150	4 9E-09	2 64E+00
^{241}Am	AS-2850	Room 170	3 3E-06	1 15E+01
^{239}Pu	AS-2904	Room 132	1 9E-07	1 20E-02
^{137}Cs	AS-551	Room 170	9 2E-08	7 99E+00
^{239}Pu	AS-3696	Room 170	1 1	6 65E+04
^{239}Pu	AS-3697	Room 170	2 2	1 39E+05
^{239}Pu	AS-3698	Room 170	58	3 59E+06
^{239}Pu	AS-3699	Room 170	10	6 49E+05
^{239}Pu	AS-3700	Room 170	25	1 57E+06
^{235}U	AS-3701	Room 170	40	8 65E+01
^{192}Ir	AS-3917	Room 164	7 2E-06	6 66E+04

(1) As of May 6, 1998

Table 12 Sealed Sources Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	may
Maintains/Repairs								
Inspects/Tests								yes

Protective features credited in the determination that the sealed sources are a Standard Industrial Hazard are shown in Table 13

Table 13 Sealed Sources Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Dispersibility	yes	Containment	Source package [S&IH]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Source package shielding [S&IH, RAD] Dosimetry, leaded clothing [RAD] Source inspection source package quality, postings work control ALARA, training, source use evaluation, source control [S&IH, RAD QA, WORK, TRAIN MAINT, ORG]

X-ray Device (Sub-hazard 3B)

A portable X-ray device (Sub-hazard 3B) is located and used in Room 164 The radiation generating device presents a ionizing radiation hazard that potentially can yield significant personnel radiation exposures Due to the distance separating the X-ray device from the CW and the public, radiation generated by the device poses no risk to either receptor For this reason, the X-ray device is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 14

Table 14 X-ray Device Hazard Activity Interation

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves							yes	
Maintains/Repairs							yes	
Inspects/Tests								yes

Protective features credited in the determination that the X-ray device is a Standard Industrial Hazard are shown in Table 15

Table 15 X-ray Device Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Radiation	yes	Remote location	Current configuration control [CONFIG]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Device, shielding [S&IH, RAD] Dosimetry [RAD] Device inspection, postings, work control, training, device control [S&IH, RAD, WORK, TRAIN, ORG]

4.1 3 Radioactive Materials (Hazard/Energy Source 4)

Category I and II SNM (Sub-hazard 4A)

Part of the mission of the Building 991 Complex is to receive, stage, and then ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium, uranium, and/or americium metals and/or oxides The radioactive materials present a significant radiological hazard that potentially can yield IW, CW, and public radiation exposures Release mechanisms for the material include (1) exposure of pyrophoric material to atmosphere with subsequent fires, (2) material involvement in non-pyrophoric, facility fires, (3) material

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involvement in container spill events, (4) material involvement in container puncture events, (5) material involvement in facility explosion events, and (6) criticality events Many of these release mechanisms are expected to be precluded due to the rigor of the Type B shipping container The Type B shipping containers containing Category I or II SNM are not opened in the Building 991 Complex Exposure of pyrophoric material to the atmosphere is also expected to be precluded since the receipt of SNM in Building 991 will comply with the requirements specified in 1-W89-HSP-31 11 (Ref 20), on-site transportation procedures, and Department of Transportation (DOT) procedures which limit the amount of known pyrophoric material The quantity of WG Pu or uranium in the Type B shipping container varies for each container Category I SNM requires two or more kilograms of plutonium metal or six or more kilograms of plutonium oxide The Category I and II SNM hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Waste Containers (Sub-hazard 4B)

Part of the mission of the Building 991 Complex is to receive, store, and then ship on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes The radioactive materials present a significant radiological hazard that potentially can yield IW, CW, and public radiation exposures Release mechanisms for the material include (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires, (2) material involvement in non-pyrophoric, facility fires, (3) material involvement in container spill events, (4) material involvement in container puncture events, (5) hydrogen generation in containers with subsequent container explosion events, (6) material involvement in facility explosions, and (7) criticality events The contaminated waste material shipping containers are not opened in the Building 991 Complex The quantity of WG Pu or uranium in the waste shipping container varies for each container type The maximum fissile material loading (in terms of WG Pu equivalent dose impact) for each analyzed container is shown in Table 16 and are based on (1) upper-bound quantities for containers within the defined waste category, in the case of LLW containers, (2) container fissionable material limits imposed by Criticality Safety, in the case of TRU waste containers other than POC containers, and (3) container fissionable material limits imposed by Criticality Safety in combination with a maximum planned americium loading, in the case of POC containers This table is presented to support development of accident scenarios (to determine the effective MAR) and should not be interpreted as Nuclear Material Safety Limits (NMSLs) for the complex

A conservative estimate of the number of TRU waste drums that can be stored in the Building 991 Complex is 4,792 drums This estimate is based on the following *assumed* room inventories and stacking arrangements

Room 134	850 drums	4 tiers	Room 135	24 drums	1 tier
Room 140/141	600 drums	3 tiers	Room 142	80 drums	2 tiers
Room 143	300 drums	3 tiers	Room 147	60 drums	1 tier
Room 148	20 drums	1 tier	Room 151	400 drums	3 tiers
Room 153	104 drums	2 tiers	Room 155	120 drums	1 tier
Room 158	56 drums	1 tier	Room 166	650 drums	4 tiers
Room 170	768 drums	4 tiers	Building 996	160 drums	1 tier
Building 998	600 drums	2 tiers			

The above room loading assumptions are not intended to be restrictions on room inventories or stacking arrangements but are used only as estimates of the building inventory These data are presented to support development of accident scenarios (to determine the effective MAR) and should not be interpreted as an overall limit for radioactive waste material for the complex Conservative assumptions dealing with damage ratios, inventories, and container contents that go into the MAR estimate for accident scenarios are expected to cover all variations of the drum totals and stacking arrangements except for significant departures (more than 25% increases) from the above assumptions The waste container hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

The chemical and physical forms of the containerized wastes vary, but are categorized by the Item Description Code (IDC) or Waste Form Code (WFC) assigned to them The wastes are contaminated primarily with WG Pu Uranium contaminated wastes may be found in the complex but are not explicitly evaluated, WG Pu postulated release evaluations are used to bound similar scenario releases involving uranium due to the significantly higher DCF associated with plutonium versus uranium Some of the wastes may be contaminated with higher concentrations of americium than normally found in WG Pu from the decay of ^{241}Pu to ^{241}Am The hazards associated with the higher americium content packages are addressed in USQD-RFP-97 0510-TLF, *Americium Quantities Greater Than Analyzed in the FSARs* (Ref 21) The Unreviewed Safety Question Determination (USQD) concluded that the existing Building 991 Complex authorization basis does not identify any controls on americium in the complex This Safety Analysis will address the issue of americium in waste containers and will identify appropriate controls associated with the material

Table 16 Analyzed Waste Container Material Loading

Container Type	Waste Type	Analyzed WG Pu Equivalent Limits
55-gallon waste drum	LLW	0 5 grams
55-gallon waste drum	TRU waste	200 grams
POC	TRU waste	1,255 grams
wooden crate	LLW	3 grams
TRUPACT II SWB	TRU waste	320 grams
metal waste box	LLW & TRU waste	3 grams (LLW) and 320 grams (TRU)

Contamination (Sub-hazard 4C)

The Building 991 Complex has handled radioactive material containers of various types throughout its history However, no identified contamination of any significance is present in the facilities Previously removed High Efficiency Particulate Air (HEPA) filters from the plenums supporting the Building 991 Complex have had no contamination of significance but are treated as LLW No waste containers and Type B shipping containers are to be opened in the facility so the generation of any new contamination is limited to accidental spills The very limited radioactive material contamination existing outside of containers presents a possible radiological hazard that potentially can yield personnel radiation exposures The HEPA filters in the plenums and the drums processed through the drum crushing activity are treated as LLW and have the potential to contain small amounts of contamination Based on the experience from past operation of the facilities and the restriction from opening containers in the facilities, contamination outside of waste containers is considered a **Standard Industrial Hazard** with no risk posed to the CW or the public and will not be further evaluated Interactions of the hazard with activities are shown in Table 17

Table 17 Contamination Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves			yes	may	may	may	yes	may
Maintains/Repairs								
Inspects/Tests								yes
Indirectly Approaches/Nears		may	yes	may			yes	yes

Protective features credited in the determination that contamination is a Standard Industrial Hazard are shown in Table 18

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Table 18 Contamination Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Dispersibility	yes	Containment of contamination	No container opening [EPWM]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Confinements [RAD] Dosimetry, respiratory protection, contamination protection clothing [RAD] No container opening, maintenance work evaluation, area surveys, radiation work permits, work control, postings, ALARA, training [EPWM, MAINT, RAD, WORK, TRAIN]

4.1.4 Thermal Energy (Hazard/Energy Source 5)

Heated Water (Sub-hazard 5A)

Heated water is used for heating of various buildings in the Building 991 Complex The heated water enters the facility in Room 166 from the adjacent building containing natural gas heated boilers From Room 166, the heated water goes to Room 137 from which it is distributed throughout the facility The heated water lines present a thermal hazard that can potentially burn facility personnel but is not a potential fire initiator since the temperature of the water is less than 201°F No radioactive materials are located close enough to heated water lines to be impacted by thermal hazards associated with hot water and, therefore, the thermal hazard associated with heated water is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 19

Table 19 Heated Water Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	may
Maintains/Repairs		may		yes				
Inspects/Tests								yes

Protective features credited in the determination that heated water is a Standard Industrial Hazard are shown in Table 20

Table 20 Heated Water Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	yes	Limitation on temperature Separation from hazardous materials	Current configuration control [CONFIG] Current configuration control [CONFIG, EPWM]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Piping, insulation [S&IH] Non-absorbent thermal protection clothing [S&IH] System inspection/monitoring, maintenance work evaluation, work control, labeling, training [S&IH, ORG, MAINT, WORK, TRAIN]

Propane (Sub-hazard 5B)

As part of the Building 991 Complex operations, flammable gas torches may be used for pipe brazing or other tasks A small, hand-held propane torch is the expected flammable gas component The torch use is not expected to be a frequent activity, but some use of the torch is expected Locations for use are not defined and may include waste storage areas The propane flammable gas associated with the torch could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to a propane explosion in proximity to containers, (2) facility fires involving propane or direct container exposure to torch flame, (3) facility explosions involving propane, and (4) rearrangement of containers with subsequent criticality events due to a propane explosion in proximity to containers In addition, propane storage tanks are located on elevated terrain, west of the Building 991 Complex and may pose a hazard to the complex if breached The propane hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Natural Gas (Sub-hazard 5C)

As part of the Building 991 Complex operations, natural gas boilers are used to heat water for portions of the facility heating system The natural gas line to the boiler building is above ground to the north-east of Building 991 (*i e*, near Room 166) The boiler building is located to the east of Room 166 and to the north of the 13 8 kV transformers Failure of the boilers or natural gas lines could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to a natural gas explosion in proximity to containers, (2) facility fires involving natural gas, (3) facility explosions involving natural gas, and (4) rearrangement of containers with subsequent criticality events due to a natural gas explosion in proximity to containers The natural gas hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Pyrophoric Materials (Sub-hazard 5D)

Part of the mission of the Building 991 Complex is to receive, stage, and then ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium or uranium metal Also, as part of the Receipt, Storage, Transfer, and Shipment of Waste activity,

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an on-site transportation approved, 10-gallon shipping container containing uranium fines was stored in the facility The radioactive material metals and fines are potentially pyrophoric and may spontaneously ignite when exposed to atmosphere The pyrophoric materials present a significant radiological hazard that potentially can yield IW, CW, and public radiation exposures following the ignition and burning of the radioactive material as covered by material fires in the Safety Analysis The Type B shipping containers and the waste drum provide protection against the exposure of the pyrophoric material to air The Type B shipping containers and the waste containers are not opened in the Building 991 Complex The quantity of WG Pu or uranium in the Type B shipping container varies for each container Category I SNM requires two or more kilograms of plutonium metal or six or more kilograms of plutonium oxide The quantity of uranium in the uranium fines 10-gallon waste drum is conservatively estimated to be 200 grams (fissionable material drum limit imposed by Criticality Safety) The 10-gallon drum containing potentially pyrophoric uranium fines is no longer in the facility but a hazard associated with a limited number of waste containers containing pyrophoric uranium fines is considered The pyrophoric radioactive material hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Electric Power System (Sub-hazard 5E)

Electric power wiring and electrical components exist throughout the Building 991 Complex Failure of the electric power system by shorts or loss of insulation could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to ignition of an explosion in proximity to containers, (2) ignition of facility fires involving combustibles, (3) ignition of facility explosions involving flammable gases, and (4) rearrangement of containers with subsequent criticality events due to ignition of an explosion in proximity to containers The electric power system hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Electric Heaters (Sub-hazard 5F)

Portions of the Building 991 Complex do not have heating support from the heated water system and alternative means for conditioning the air in the locations are required Room 166 and Room 167 of Building 991 and Building 989 have electric heaters to maintain proper temperatures in the areas Room 166 has three ceiling-mounted heaters, Room 167 has one heater, and Building 989 has two heaters The electric heaters present thermal and electrical hazards that can potentially result in the initiation of a fire, burn personnel, and electrocute personnel No radioactive materials are located in Room 167 or Building 989 but the diesel generator serving the complex is located in Building 989 Fires initiated by the heaters in Building 989 could impact the complex electric power supply, but the loss of electric power to the complex is dominated by other electrical system failure modes Fires impacting backup power supplies would have little contribution to the overall frequency associated with complex loss of power A fire in Room 167 is not expected to propagate to other parts of Building 991 (i e, Room 166) due to the concrete wall between the two rooms and the two windows in Room 167 that would fail during any significant fire and reduce the wall heat loading

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Unlike Room 167 and Building 989, Room 166 may be used for waste container storage The heaters in Room 166 are ceiling mounted, which reduces the thermal and fire initiation hazard posed by the heaters on the waste containers potentially stored in the room General fire initiation frequencies corresponding to electric power system failures and personnel errors are used in the Safety Analysis and bound any fire initiation frequency contribution related to the elevated heaters and stored waste containers. Due to the location of the electric heaters relative to any sources of radioactive material and the frequency dominance of other initiators dealing with fires over electric heater initiation of fires, the thermal, fire initiation, and electrocution hazard associated with the electric heaters is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 21

Table 21 Electric Heaters Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that the electric heaters are a Standard Industrial Hazard are shown in Table 22

Table 22 Electric Heaters Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	yes	Maintenance of system insulation Separation from hazardous materials Separation from combustibles	System maintenance [MAINT] Current configuration control [CONFIG, EPWM] Combustible control [FIRE]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Elevation, heater enclosures [S&IH] Thermal protection clothing, insulated clothing [S&IH] System inspection/monitoring, maintenance work evaluation, work control, postings, training [S&IH, FIRE, ORG, MAINT, WORK, TRAIN]

Diesel Generator, Day Tank, Batteries (Sub-hazard 5G)

The Building 991 Complex is supported by a backup power diesel generator and associated auxiliary equipment Building 989 contains a diesel generator, a day tank containing up to 180 gallons of diesel fuel, and starting batteries This combined set of equipment presents thermal and electrical hazards that can potentially result in the initiation of a fire, burn personnel, and electrocute personnel No radioactive materials are located in or near Building 989 Fires initiated by the diesel generator and auxiliary equipment could impact the complex electric power supply, but the loss of electric power to the complex is dominated by other electrical system failure modes Fires impacting backup power supplies would have little contribution to the overall frequency associated with complex loss of power Due to the location of the diesel generator and auxiliary equipment relative to any sources of radioactive material and the frequency dominance of other initiators dealing with loss of electric power over fires in the diesel generator building, the thermal, fire initiation, and electrocution hazard associated with the diesel generator and auxiliary equipment is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 23

Table 23 Diesel Generator, Day Tank, Batteries Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that the diesel generator, day tank, and batteries are a Standard Industrial Hazard are shown in Table 24

Table 24 Diesel Generator, Day Tank, Batteries Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	yes	Maintenance of system barriers Separation from hazardous materials Separation from combustibles	System maintenance [MAINT] Current configuration control [CONFIG, EPWM] Combustible control [FIRE]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Separate facility, locked facility [CONFIG, ORG] Thermal protection clothing, insulated clothing [S&IH] System inspection/monitoring, maintenance work evaluation, work control, postings, training [S&IH, FIRE, ORG, MAINT WORK, TRAIN]

Transport Vehicles (Sub-hazard 5H)

Part of the mission of the Building 991 Complex is to receive and ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium, uranium,

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and/or americium metals and/or oxides and on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes Also, various non-radioactive material deliveries and shipments will occur as part of normal operations and tenant activities The use of transportation vehicles during the conduct of these receipt and shipment activities presents a potential flammable material hazard from the diesel or gasoline fuels in the vehicles and an ignition source from the hot surfaces of the vehicles that can lead to facility fires In conjunction with the radioactive material receipt and shipment, radioactive material containers are located on or in proximity to the transport vehicles The transport vehicle hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

4.1.5 Pressure Sources (Hazard/Energy Source 6)

Compressed Air, Compressors (Sub-hazard 6A)

The Building 991 Complex is supported by two operational and one out-of-service air compressor and the corresponding pressurized air tank and piping Shutoff air pressure for the air compressors is between 80 and 90 pounds per square inch This combined set of equipment presents pressure hazards that can potentially result in the generation of missiles (*i e*, pieces of equipment traveling at high velocity due to air system rupture) and personnel injury Pressurized piping goes throughout the facility, including through waste storage areas, however, the compressors and the air tank are located in the utility rooms (*i e*, Room 130 and Room 137) and in Building 985, which are not used for waste container storage Due to the relatively low pressures associated with the system, the pressure hazard associated with the air compressors and auxiliary equipment is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 25

Table 25 Compressed Air, Compressors Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves		may		may			yes	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that the compressed air system and compressors are a Standard Industrial Hazard are shown in Table 26

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Table 26 Compressed Air, Compressors Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	yes	Limitation on pressure Separation from hazardous materials	Current configuration control [CONFIG] Current configuration control [CONFIG, EPWM]
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Piping, components, relief valves [S&IH] Eye shields [S&IH] System inspection/monitoring, maintenance work evaluation, work control, labeling, training, lockout/tagout [S&IH, ORG, MAINT, WORK, TRAIN]

Drum Crusher (Sub-hazard 6B)

Part of the mission of the Building 991 Complex is to compact drums that are to be shipped from the Site as waste A gasoline fuel powered, hydraulic drum crusher located in Building 984 performs this function No TRU waste containers are stored in Building 984, however, some LLW containers may be staged in the building following generation prior to removal to an allowed storage location The drums that are treated as waste in this activity are classified as LLW but generally have negligible contamination The relatively high pressures associated with the drum crusher and the low levels of contamination present a pressure hazard and a contamination hazard (see Section 4 1 3, Sub-hazard 4C) Due to the negligible radioactive material present in proximity to the drum crusher, the pressure hazard associated with the drum crusher is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 27

Table 27 Drum Crusher Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves			yes				yes	
Maintains/Repairs				may				
Inspects/Tests								may

Protective features credited in the determination that the drum crusher is a Standard Industrial Hazard are shown in Table 28

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Table 28 Drum Crusher Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	yes	Limitation on contamination Separation from hazardous materials	LLW restriction [EPWM] Current configuration control [CONFIG, EPWM]
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Component [S&IH] Eye shields [S&IH] Component inspection, maintenance work evaluation, work control, training [S&IH, MAINT, WORK, TRAIN]

Pressurized Metal Waste Containers (Sub-hazard 6C)

Part of the mission of the Building 991 Complex is to receive, store, and then ship on-site transportation approved metal, sealed shipping containers containing plutonium, uranium, and/or americium contaminated wastes The radioactive decay of the waste material has the potential to interact with other waste materials and produce gases (*e g*, as a result of radiolysis) The generation of hydrogen gas is one example of this gas generation and drum pressurization process The potential effects of other gases that may be formed that could lead to pressurization of the waste container are considered to be bounded by the hydrogen gas situation due to the explosive nature of hydrogen (*i e*, hydrogen gas pressure could be significantly lower than waste container internal failure pressure and still lead to container failure as a result of the rapid combustion of the hydrogen) The pressurized metal waste containers hazard is further evaluated under the "hydrogen generation in metal waste containers" hazard discussed in Section 4 1 11

4.1.6 Kinetic Energy (Hazard/Energy Source 7)

Vehicles, Material Handling Equipment (Sub-hazard 7A)

Part of the mission of the Building 991 Complex is to receive and ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium, uranium, and/or americium metals and/or oxides and to receive, transfer, and ship on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes Also, various non-radioactive material receipts, transfers, and shipments will occur as part of normal operations and tenant activities The use of material handling equipment or vehicles during the conduct of these receipt, transfer, and shipment activities presents a potential kinetic energy hazard from the movement and mass of the equipment The equipment can impact staged Type B shipping containers, staged waste containers, or stored waste containers that could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container breach, (2) spill of container contents following impact-induced drop events, (3) spill of container contents following puncture of the container, and (4) rearrangement of container inventories with subsequent criticality events due to breach of containers The

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vehicles, material handling equipment hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Rotating Machinery & Tools (Sub-hazard 7B)

Rotating machinery is located in various areas of the Building 991 Complex including Room 130 (utility room containing fans and a compressor) and Building 985 (plenum building containing fans and a compressor) No significant quantities of radioactive material beyond contamination levels are located close enough to rotating machinery to be impacted by the kinetic energy hazards associated with the machinery Some rotating tools (*e g*, drills, saws) may be used during the conduct of construction and maintenance tasks but contain insufficient energy to cause failure of radioactive material containers except by direct application of the tool to the container This latter hazard is considered sabotage and is not addressed in the Safety Analysis Due to the location of high kinetic energy equipment away from radioactive materials and the low energy associated with rotating tools (*i e*, missiles from tool failure do not have much momentum) that may be used in close proximity to radioactive material containers, the kinetic energy hazard associated with rotating machinery and tools is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 29

Table 29 Rotating Machinery & Tools Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves		may		may			yes	
Maintains/Repairs				yes				
Inspects/Tests								yes
Brings Near Radioactive Material		may		may			may	

Protective features credited in the determination that rotating machinery and tools are a Standard Industrial Hazard are shown in Table 30

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Table 30 Rotating Machinery & Tools Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	yes	Separation from hazardous materials	Current configuration control [CONFIG, EPWM] for fixed machines, maintenance work evaluation, work control [MAINT, WORK] for tools
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Component enclosures, speed governors [S&IH] Eye shields, non-loose clothing [S&IH] System inspection/monitoring, tool inspection, maintenance work evaluation, work control, postings, training, lockout/tagout [S&IH, ORG, MAINT, WORK, TRAIN]

4.1.7 Potential Energy (Hazard/Energy Source 8)

Overhead Cranes (Sub-hazard 8A)

Overhead cranes are located in various areas of the Building 991 Complex Specifically, a 3 ton capacity crane is located in Room 134 (room is currently used for storage of waste containers), a 1 ton capacity crane is located in Room 170 (dock area, room may be used for storage of waste containers), a 750 pound capacity crane is located in each of Rooms 164 and 165 (rooms are not used for storage), a 500 pound capacity crane is located outside in the east dock area (area is not used for storage), a crane is located in Room 147 (room is not used for storage), and a crane is located in Building 996 (building is currently used for waste container storage) Only the crane in Room 164 is currently being used in the performance of non-destructive testing (NDT) work All other cranes are not to be used and are locked out of operation Drops of loads onto radioactive material containers is not considered in the Safety Analysis due to the non-use of the cranes in areas where containers may be located The crane equipment is indirectly considered in the analysis of seismic events as part of the debris that may fall onto stored waste containers Due to the location of the single crane still in use away from radioactive materials and the non-use of cranes that may be located above radioactive material containers, the potential energy hazard associated with cranes is considered a **Standard Industrial Hazard** and will not be further evaluated **However, the cranes will be considered as part of the elevated debris that may impact waste containers during seismic events** Interactions of the hazard with activities are shown in Table 31

Table 31 Overhead Cranes Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves							yes	
Maintains/Repairs				may				
Inspects/Tests								yes

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Protective features credited in the determination that the overhead cranes are a Standard Industrial Hazard are shown in Table 32

Table 32 Overhead Cranes Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	yes	Separation from hazardous materials	Current configuration control [CONFIG, EPWM]
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	none none Component inspection/surveillance, maintenance work evaluation, work control, postings, training, lockout/tagout [S&IH, MAINT, WORK, TRAIN]

Raised Loads on Forklifts (Sub-hazard 8B)

Part of the mission of the Building 991 Complex is to receive and ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium, uranium, and/or americium metals and/or oxides and to receive, transfer, and ship on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes The use of forklifts during the conduct of these receipt, transfer, and shipment activities presents a potential energy hazard (*i e*, potential for dropping of containers) from the raising of the forklift loads Type B shipping container loads on forklifts are generally not required to be raised to any height above that necessary to clear floor obstructions but the potential exists for stacking Type B shipping containers to a second tier in Room 170 during the actual transport vehicle loading and unloading procedures This second tier stacking hazard is not a threat to Type B shipping containers Waste container loads on forklifts may be required to be raised to heights sufficient to allow for stacking of the containers (*i e*, up to four high for drums and up to two high for boxes) Also, the waste drum loads may be located on pallets containing up to 4 containers These raised loads on forklifts present a potential energy hazard that could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container drops and breach, (2) spill of container contents following drop events, and (3) rearrangement of container inventories with subsequent criticality events due to drops of containers The waste container raised loads on forklift hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Stacked Waste Containers (Sub-hazard 8C)

Part of the mission of the Building 991 Complex is to store on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes Waste container storage may require stacking of up to 4 drums or 2 boxes in some locations The waste drums may be located on pallets containing up to 4 containers These

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stacked waste containers present a potential energy hazard that could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container falls and breach, (2) spill of container contents following falling events, and (3) rearrangement of container inventories with subsequent criticality events due to container falling The stacked waste containers hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

4.1.8 Toxic, Hazardous, or Noxious Materials (Hazard/Energy Source 9)

General Industrial Chemicals (Sub-hazard 9A)

The chemical and other non-radioactive material inventory of the Building 991 Complex consists of a wide variety of materials due to the numerous tenant activities that have been and/or continue to be conducted in the facilities A total of 47 different hazardous materials were identified as being in the facility based on the ICMS and facility databases Many of the materials on the list are no longer needed by the facility and will be removed over time as excess chemicals Some of the listed materials are currently being used as part of facility operation and tenant activities In addition to the listed chemicals, three new hazardous materials and one repeated hazardous material were identified as part of the facility (1) asbestos in floor tiles, ceiling panels, and walls, (2) beryllium in some waste containers, (3) lead (repeat) in paints on facility surfaces, and (4) polychlorinated biphenyls (PCBs) in transformer fluids and fluorescent lighting Of these 50 hazardous materials, 17 materials exceed 1% of the lowest value of the corresponding RQ, TQ, and TPQ quantities (*i e*, if a material has TQ, TPQ, and/or RQ assigned values, 1% of the lowest of the assigned value is compared to the estimated quantities of the material in the facility) While the Safety Analysis would only be concerned with chemical inventories exceeding the TQ or TPQ threshold quantities, those chemicals in excess of 1% of a threshold are presented to indicate the types of chemicals that exist in the Building 991 Complex in any notable quantities relative to their hazard potential These 17 hazardous materials are listed in Table 33 The hazardous materials that exceed or have the potential to exceed a TQ, TPQ, or RQ threshold quantity are shown in *italics* in the table

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Table 33 Chemicals / Hazardous Materials of Note in Building 991 Complex

Material	Threshold Type	Threshold Level (pounds)	Quantity (pounds)	Possible Locations
Acetic Acid (in fixer, developer, replenisher)	RQ	5,000	220 to 225	Rooms 109, 110, 160
Asbestos (worst case friable)	*RQ*	*1*	*> 1*	*Throughout*
Beryllium	*RQ*	*10*	*> 10*	*Room 158*
Cadmium (in nickel-cadmium batteries)	*RQ*	*10*	*> 10*	*Rooms 105, 106, 107, 108*
Cumene Hyproperoxide (in adhesive)	RQ TQ	10 5,000	< 1	Room 105
Cupric Chloride	*RQ*	*10*	*25 to 30*	*Rooms 109, 110*
Dibutyl Phthalate (in resin)	RQ	10	5 to 10	Rooms 109, 110
Hydrofluoric Acid	RQ TPQ TQ	100 100 1,000	1 to 5	Rooms 109, 110
Hydroquinone (in developer, replenisher)	RQ TPQ	100 500	10 to 15	Rooms 105, 160
Lead	*RQ*	*10*	1 to 5 *> 10*	Room 130 *Throughout*
Methylene Chloride (in paint removers)	RQ	1,000	45 to 50	Rooms 105, 155
Nitric Acid (worst case 94 5% by weight)	TQ	500	5 to 10	Rooms 109, 110
Polychlorinated Biphenyls (PCBs)	*RQ*	*1*	*> 1*	*Outside and throughout*
Potassium Ferricyanide (Potassium Cyanide)	RQ TPQ	10 100	1 to 5	Rooms 109, 110
Potassium Hydroxide (in developer, replenisher)	RQ	1,000	10 to 15	Room 160
Sodium Nitrite (in corrosion inhibitor)	RQ	100	25 to 30	Room 137
Sulfuric Acid (pure and in fixer, replenisher)	RQ TPQ	1,000 1,000	25 to 30	Rooms 109, 110, 160
Xylene (in caulk)	RQ	100	1 to 5	Rooms 105, 109, 110, 165

Based on Table 33, no hazardous material exceeds a corresponding TQ or TPQ quantity Five hazardous materials are identified that potentially exceed corresponding RQ values Only one chemical (cupric chloride) is actually known to exceed its assigned RQ value Each of these hazardous materials is discussed in later sub-sections

The Building 991 Complex is not permitted to store Resource Conservation and Recovery Act (RCRA) wastes There is a RCRA Satellite Area for the accumulation of spent nickel-cadmium batteries in support of a tenant activity, which is discussed in the Batteries

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sub-section The chemical hazard associated with the RCRA controlled waste in the facility is very small and is not a concern The Building 991 Complex is currently not permitted to store or stage TSCA wastes, which are discussed under the PCB sub-section

Due to the limited quantities of hazardous materials (*i e*, quantities in the Building 991 Complex do not exceed threshold values) general industrial chemicals, excluding those discussed below, are considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 34

Table 34 General Industrial Chemicals Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves	yes	may		may			yes	
Maintains/Repairs								
Inspects/Tests								may

Protective features credited in the determination that general industrial chemicals are a Standard Industrial Hazard are shown in Table 35

Table 35 General Industrial Chemicals Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment Limited quantities	Chemical package [S&IH] Quantity control [ORG, S&IH]
Mechanical Interaction	no		
Chemical Interaction	yes	Separation from radioactive materials	Current configuration control [CONFIG, EPWM]
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Chemical package [S&IH] Protective clothing, eyewash & safety showers, respirators [S&IH] Chemical inventory, area restrictions, area surveys, maintenance work evaluation, work control, postings, training [S&IH, ORG, MAINT, WORK, TRAIN]

<u>Cupric Chloride, Dihydrate (Sub-hazard 9B)</u>

The total complex contents of cupric chloride are between 25 and 30 pounds as compared to a RQ value of 10 pounds The chemical is evenly distributed in 5 separate containers, located in Rooms 109 and 110 (part of the metallography laboratory), and each individual container is below the RQ threshold Since cupric chloride has no defined TQ or TPQ value, it can be argued

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that the dominant risk from this chemical is to the IW and/or the environment and the chemical does not pose a significant risk to the CW or the public Also, the chemical is not located near any waste storage areas and poses no threat to waste container storage inventories Due to the location of cupric chloride away from radioactive materials and the low CW and public consequences associated with a chemical release, the toxic, hazardous, or noxious chemicals hazard associated with cupric chloride is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 36

Table 36 Cupric Chloride Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves	may						yes	
Maintains/Repairs								
Inspects/Tests								yes

Protective features credited in the determination that cupric chloride is a Standard Industrial Hazard are shown in Table 37

Table 37 Cupric Chloride Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment Limited quantities	Chemical package [S&IH] Quantity control [ORG, S&IH]
Mechanical Interaction	no		
Chemical Interaction	yes	Separation from radioactive materials	Current configuration control [CONFIG, EPWM]
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Chemical package [S&IH] Protective clothing, eyewash & safety showers [S&IH] Chemical inventory, area surveys, work control, postings, training [S&IH, WORK, TRAIN]

Beryllium (Sub-hazard 9C)

Beryllium metal parts are located in multiple 55-gallon drums in Room 158 (classified vault) The amount of beryllium is greater than the RQ threshold of 10 pounds Beryllium has no defined TQ or TPQ values The only possible type of CW or public exposure is through inhalation According to data in the Risk Assessment Information System (RAIS), a database maintained by the Oak Ridge National Laboratory, (Ref 22), acute toxicity effects occur at concentrations above 100 grams of beryllium per cubic meter Carcinogenic effects of beryllium inhalation are related to long-term (i e , occupational) exposures It is not expected that any

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accident involving beryllium would result in concentrations at the CW and public exceeding 100 g/m^3 Also, any exposure would be short-term Therefore, the toxic, hazardous, or noxious chemicals hazard associated with the beryllium inventory is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 38

Table 38 Beryllium Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves						yes		
Maintains/Repairs								
Inspects/Tests								yes

Protective features credited in the determination that beryllium is a Standard Industrial Hazard are shown in Table 39

Table 39 Beryllium Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment	Current material form control [EPWM, S&IH]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	none none Current material form control [EPWM, S&IH]

Asbestos (Sub-hazard 9D)

Containerized wastes with asbestos may be generated in the Building 991 Complex The asbestos currently exists in some floor tiling (particularly in the south-west area of the basement), potentially exists in some ceiling tiles, and potentially exists in some room partitions or walls The exact amount of asbestos, particularly friable asbestos, is not known but the friable asbestos is assumed to exceed the RQ threshold of 1 pound Asbestos has no defined TQ or TPQ value The dispersibility of asbestos in the floor tiling and ceiling tiles and in waste containers is currently limited, but the asbestos does pose a risk to the IW if the material is disturbed According to RAIS (Ref 23), the acute toxicity effects associated with inhalation of asbestos are temporary breathing difficulties These breathing difficulties were due to "high concentration" in an occupational setting According to RAIS, subchronic and chronic toxicity effects are due to long-term exposure (at least 6 months) in an occupational setting Carcinogenic effects ar also

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related to long-term exposures Any CW or public exposure to asbestos would be short-term and would only be expected, at worst, to cause the acute toxicity effects described above Therefore, the chemical hazard associated with asbestos is considered a **Standard Industrial Hazard** and will not be further evaluated. Interactions of the hazard with activities are shown in Table 40

Table 40 Asbestos Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves		may	yes	may			may	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that asbestos is a Standard Industrial Hazard are shown in Table 41

Table 41 Asbestos Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment	Current configuration control, waste containers [CONFIG, S&IH, EPWM]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Current configuration control, waste containers [CONFIG, S&IH, EPWM] Protective clothing, respirators [S&IH] Area restrictions, area surveys, maintenance work evaluation, work control, postings, training [S&IH, ORG, MAINT, WORK, TRAIN]

<u>Polychlorinated Biphenyls (PCBs) (Sub-hazard 9E)</u>

Containerized wastes with TSCA-regulated PCBs may be generated in the Building 991 Complex but a permit must be obtained for a staging area location prior to generating the waste Controls mandated by TSCA regulations are credited as preventive and mitigative measures before the PCBs are transferred to a permanent TSCA storage area outside of the Building 991 Complex The PCBs currently exist in the fluids of some transformers (one in Room 130 and two outside) and potentially exists in some fluorescent lighting fixtures The exact quantity of PCBs in the Building 991 Complex is not known, but it is expected that the total quantity exceeds the RQ of 1 pound PCBs have no defined TQ or TPQ values The PCBs that may exist in the lighting fixtures are not readily dispersible but the transformer fluid PCBs can be dispersed PCBs in waste containers could be released during a fire or spill A fire involving PCBs would volatilize some of the PCBs and allow them to be transported away from the immediate area The volatilized PCBs could result in CW or public exposure through inhalation According to RAIS (Ref 24), acute toxicity effects expected include anorexia, nausea, edema, abdominal pain, ocular discharge, and burning sensations in the skin and eyes, although no specific data exists Subchronic toxicity effects are documented as mild to moderate chloracne in 50% of workers exposed to 0 1 mg/m^3 for an average of 14 3 months Suspected carcinogenic effects of PCB inhalation are related to long-term (i e , occupational) exposures Exposure of both the CW and public would be short-term Due to the low CW and public consequences associated with a chemical release of PCBs, the chemical hazard associated with PCBs is considered a **Standard Industrial Hazard** and will not be further evaluated. Interactions of the hazard with activities are shown in Table 42

Table 42 Polychlorinated Biphenyls Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves	may	may	yes	may			may	
Maintains/Repairs				may				
Inspects/Tests								yes

Protective features credited in the determination that polychlorinated biphenyls are a Standard Industrial Hazard are shown in Table 43

Table 43 Polychlorinated Biphenyls Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment	Current configuration control, waste containers [CONFIG, S&IH, EPWM]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers	Current configuration control, waste containers [CONFIG, S&IH, EPWM]
		Protective equipment	Protective clothing [S&IH]
		Administrative	Maintenance work evaluation, work control, postings training [S&IH, MAINT, WORK, TRAIN]

Lead (Sub-hazard 9F)

Containerized wastes with lead may be generated in the Building 991 Complex but will require a RCRA satellite storage area for temporary staging Controls mandated by RCRA

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regulations are credited as preventive and mitigative measures before the waste lead is transferred to a permanent RCRA storage area outside of the Building 991 Complex In addition, non-waste lead exists as a constituent in a sealant found in two containers The lead potentially exists in some painted surfaces (*i e*, lead based paints) and potentially exists in some batteries (see *Batteries (Sub-hazard 9G)* sub-section) used in the complex The lead in batteries and the paint is relatively difficult to disperse, but the potential exists that lead in painted surfaces could become dispersible as the paint peels from the surface as it is disturbed The exact amount of lead, particularly dispersible lead, is not known but the lead is assumed to exceed the RQ threshold of 1 pound Since lead has no defined TQ or TPQ value, it can be argued that the dominant risk from this hazardous material is to the IW and/or the environment and the material does not pose a significant risk to the CW or the public The dispersibility of the lead is currently limited, but the lead may pose a risk to the IW, if the material is disturbed Due to the lack of dispersibility of the material, the toxic, hazardous, or noxious chemicals hazard associated with lead is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 44

Table 44 Lead Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves	yes	may	yes	may			yes	
Maintains/Repairs				may				
Inspects/Tests								may

Protective features credited in the determination that lead is a Standard Industrial Hazard are shown in Table 45

Table 45 Lead Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment	Current configuration control, waste containers [CONFIG, S&IH, EPWM]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Current configuration control, waste containers [CONFIG, S&IH, EPWM] Protective clothing [S&IH] Area restrictions, area surveys, maintenance work evaluation, work control, postings, training [S&IH, ORG, MAINT, WORK, TRAIN]

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Batteries (Sub-hazard 9G)

Batteries containing lead exist in the facility In addition, a RCRA satellite storage area in Room 106 is used to accumulate spent nickel-cadmium batteries Controls mandated by RCRA regulations are credited as preventive and mitigative measures before the nickel-cadmium batteries are transferred to a permanent RCRA storage area outside of the Building 991 Complex The dispersibility of the hazardous constituents of the batteries is relatively low and these hazardous materials do not pose a significant risk to the CW and the public Due to the lack of dispersibility of the hazardous materials found in batteries, the toxic, hazardous, or noxious chemicals hazard associated with batteries are considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 46

Table 46 Batteries Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves		may	may	may	may	yes	yes	
Maintains/Repairs				may				
Inspects/Tests								may

Protective features credited in the determination that batteries are a Standard Industrial Hazard are shown in Table 47

Table 47 Batteries Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Toxic	yes	Containment	Component package, waste container [S&IH, EPWM]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers	Component package, waste container [S&IH, EPWM]
		Protective equipment	Protective clothing, eyewash & safety showers [S&IH]
		Administrative	Component inspections, work control, training [S&IH, WORK, TRAIN]

Diesel Fuel (Gasoline) (Sub-hazard 9H)

Diesel fuel or gasoline currently exists in a Building 989 180-gallon diesel generator day tank, in a 1,000-gallon diesel generator fuel tank located above ground and east of Building 989, and in the gasoline tank of the drum crusher in Building 984 Since diesel fuel and gasoline have

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no defined RQ, TQ, or TPQ values, it can be argued that the dominant risk, if any, from these chemicals is to the IW and/or the environment and the chemicals do not pose a significant risk to the CW or the public The risks associated with the use of diesel fuel or gasoline is a commonly accepted risk by the public Due to the low CW and public consequences associated with a chemical release, the toxic, hazardous, or noxious chemicals hazard associated with diesel fuel and gasoline is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 48

Table 48 Diesel Fuel (Gasoline) Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves				may			yes	
Maintains/Repairs								
Inspects/Tests								may

Protective features credited in the determination that diesel fuel is a Standard Industrial Hazard are shown in Table 49

Table 49 Diesel Fuel (Gasoline) Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Storage tanks [S&IH] none Chemical inventory, work control, training [S&IH, WORK, TRAIN]

4 1 9 Inadequate Ventilation (Hazard/Energy Source 10)

Unventilated Tunnels and Areas (Sub-hazard 10A)

Building 991 has several areas with limited air interfaces to the outside (1) Corridor B, Corridor C, and Buildings 996, 997, 999, (2) Corridor A and Building 998 (Room 300), and (3) the basement of the facility The Corridor B set of areas is currently ventilated by the Building 985 exhaust fans and plenum The area can communicate with Building 991 (into north hallway) and with the outside (to the west dock area) A vault door separates the north part of Corridor B from the upper ("V") portion of the inverted "Y" tunnel arrangement and potentially restricts air flow A loss of Building 985 ventilation could lead to stagnation of the air behind the vault door

The Corridor A set of areas is currently ventilated by a small exhaust system in Room 300 and the Building 991 exhaust fan and plenum The area can only communicate with Building 991 (into north hallway) A vault door separates the area from Building 991 A loss of Building 991 ventilation, including the small exhaust system, could lead to stagnation of the air behind the vault door

The basement is not ventilated It would appear that the doors into the basement serve to ventilate the basement in a limited fashion The area can communicate with Room 130 (utilities room on ground floor) and with the outside (to east dock area) Regular metal doors separate the basement from the two interfaces Stagnation of the air in the basement is expected but no mechanisms exist for air displacement, oxygen depletion, or noxious gas entry The major concerns would deal with the buildup of radon gas and/or asbestos fibers

The stagnation of air in confined areas can lead to IW injuries due to asphyxiation or noxious gas inhalation, in some cases The stagnant air has no impact on waste storage containers and poses no risk to the CW and the public Therefore, the inadequate ventilation hazard associated with unventilated tunnels and areas is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 50

Table 50 Unventilated Tunnels and Areas Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves			yes	may		yes	yes	
Maintains/Repairs								
Inspects/Tests								may
Indirectly Approaches/Nears		may		may				may

Protective features credited in the determination that unventilated tunnels and areas are a Standard Industrial Hazard are shown in Table 51

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Table 51 Unventilated Tunnels and Areas Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Asphyxiant/Toxic	yes	Monitor Ventilate	Area surveys/monitoring [ORG, S&IH, EPWM] Current configuration control [ORG, CONFIG]
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	no		
Worker Safety	yes	Physical barriers Protective equipment Administrative	Locked doors [ORG, S&IH] Breathing air [S&IH] Area restrictions, area surveys, work control, postings, training [S&IH, ORG, EPWM, WORK, TRAIN]

4.1.10 Material Handling (Hazard/Energy Source 11)

Receipt and Shipment of Waste Containers at the Dock (Sub-hazard 11A)

Part of the mission of the Building 991 Complex is to receive and ship on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes The conduct of these receipt and shipment activities presents a potential material handling hazard The handling of waste containers could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container breach, (2) spill of container contents following puncture events, and (3) rearrangement of containers with subsequent criticality events due to container movements The receipt and shipment of waste containers at the dock hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Receipt and Shipment of SNM Containers at the Dock (Sub-hazard 11B)

Part of the mission of the Building 991 Complex is to receive and ship DOT approved, Type B shipping containers containing Category I and II quantities of plutonium, uranium, and/or americium metals and/or oxides The conduct of these receipt and shipment activities presents a potential material handling hazard The handling of SNM containers could result in (1) exposure of pyrophoric metal to atmosphere with subsequent fires due to container breach, (2) spill of container contents following puncture events, and (3) rearrangement of containers with subsequent criticality events due to container movements The receipt and shipment of SNM containers at the dock hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Movement of Waste Containers in the Facility (Sub-hazard 11C)

Part of the mission of the Building 991 Complex is to store on-site transportation approved shipping containers containing plutonium, uranium, and/or americium contaminated wastes that may require waste container movements for inspections, as a result of interactions with other activities, during LLW container generation, or in order to remove specific waste

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containers The conduct of these waste container movements presents a potential material handling hazard The handling of waste containers could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container breach, (2) spill of container contents following puncture events, and (3) rearrangement of containers with subsequent criticality events due to container movements The movement of waste containers in the facility hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

4.1.11 Other Hazards (Hazard/Energy Source 13)

Hydrogen Generation in Metal Waste Containers (Sub-hazard 13A)

Part of the mission of the Building 991 Complex is to receive, store, and then ship on-site transportation approved metal, sealed shipping containers containing plutonium, uranium, and/or americium contaminated wastes The radioactive decay of the radiological waste material has the potential to interact with hydrogenous waste materials and produce hydrogen and oxygen gases Hydrogen and oxygen generation in drums has led to a concern about potential for hydrogen explosion accidents (*i e*, container explosions)

The Los Alamos Technology Office report, *Plutonium and Uranium Solutions Safety Study* (Ref 25), documents some early effort to understand the radiolytic hydrogen hazard in drums and tanks USQDs that have evaluated the hydrogen explosion risk associated with the handling and the storage of drums include *Movement of Drums Containing Unvented Hydrogen Gas Within Building 371,* USQD-371-95 0170-MDT (Ref. 26), and *Movement and Storage of 55 Gallon Drums in Unfiltered Areas Suspected of Having Hydrogen Accumulated in Drum Space,* USQD-RFP-95 0180-DSR (Ref 27) Radiolytic hydrogen generation has been evaluated in several technical reports including *Evaluation of Residue Drum Storage Safety Risks* (Ref 28), and *Safety Analysis of Hydrogen Generation in Drums Containing Plutonium Contaminated Materials* (Ref 29) Calculations to predict pressure rise in unvented drums due to radiolytic gas generation in drums are contained in Nuclear Safety Calculation, *Building 371/374 BIO Support Calculation - Explosions*, 96-SAE-025 (Ref 30) Hydrogen explosions in metal waste containers generate sufficient pressure to result in the loss of the container lid A concurrent fire involving the waste container contents is judged not to occur following the overpressurization and lid loss due to the rapidity and low energy of the excursion (Ref 31) The hydrogen generation in metal waste containers hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Battery Charging Station (Sub-hazard 13B)

Two battery charging stations exist in the Building 991 Complex (1) in Room 136 and (2) in Corridor B near the intersection of the three corridors forming an inverted "Y" (*i e*, stem of "Y" faces north) The battery charging stations support the re-charging of electric forklift batteries The battery charging stations present thermal and explosion hazards that can potentially result in the initiation of a fire, burn personnel, and injure personnel from explosion-generated missiles No radioactive materials are located in Room 136 or in the portion of Corridor B near the charging station

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Room 136 lies between Room 134 (waste storage area) and Room 170 (potential waste storage area, waste receipt and shipment area) and has line of sight to some stored waste containers in Room 134 Fires initiated by the battery charging are expected to be confined to Room 136 due to the separation between the station and probable combustible loads in the facility Explosion generated missiles with sufficient energy to impact waste containers are also expected to be confined to the battery charging station due to the separation distance The Corridor B battery charging station is not located near any waste storage areas and fires or explosions at that station would be confined to the corridor

Due to the location of the battery charging stations relative to any sources of radioactive material, the thermal and explosion hazards associated with the battery chargers are considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 52

Table 52 Battery Charging Station Hazard Activity Interaction

	ACTIVITY							
INTERACTION	**CHEM**	**CON**	**GEN**	**MAINT**	**SNM**	**WASTE**	**RA**	**SURV**
Operates/Uses/Manipulates/Moves		may	yes		yes	yes	yes	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that battery charging stations are a Standard Industrial Hazard are shown in Table 53

Table 53 Battery Charging Station Hazard Protective Features

ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	yes	Separation from hazardous materials	Current configuration control [CONFIG, EPWM]
Chemical Interaction	no		
Thermal Interaction	yes	Separation from hazardous materials Separation from combustibles	Current configuration control [CONFIG, EPWM] Combustible control [FIRE]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Component enclosures [S&IH] Protective clothing, eye shields [S&IH] Component inspection, work control, postings, training, lockout/tagout [S&IH, WORK, TRAIN]

Tunnel Degradation and Leakage (Sub-hazard 13C)

The Building 991 Complex has three sets of tunnels connecting Building 991 to Buildings 996, 997, 998, and 999 Corridor A connects to Building 998 (Room 300) Corridor B connects directly to Building 996 and Corridor B Corridor B connects to Corridor C and Buildings 997 and 999 Buildings 996 and 998 (Room 300) are areas that are currently designated for waste container storage

The degradation of the tunnels could lead to failure of the tunnel roof with subsequent influx of soil from above The collapse of a tunnel could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container breach from structure impacts, (2) spill of container contents following container breach from structure impacts, (3) spill of container contents following puncture events as a result of structure impacts, and (4) rearrangement of container inventories with subsequent criticality events due to container breach from structure impacts The leakage of tunnels, other than acting as a precursor to tunnel collapse, should pose no risk to the IW (other than presenting slippery surfaces), the CW, or the public due to the limited amount of water involved in the leakage (the tunnels are above the aquifer and leakage is a result of rain or snow melt percolating through the soil) The tunnel degradation and leakage hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Diesel Fuel (Gasoline) Storage Tank Combustibles (Sub-hazard 13D)

The Building 991 Complex is supported by a backup power diesel generator that utilizes a 180-gallon day tank and a 1,000-gallon fuel supply tank Building 989 contains the day tank The fuel supply tank is located above ground and just east of Building 989 Also, the Building 991 Complex is supported by a drum crusher that utilizes a small gasoline fuel tank to run the drum crusher motor The drum crusher is located in Building 984 Additional diesel fuel quantities are associated with transport vehicles, which are discussed in Section 4 1 4, *Thermal Energy*, Sub-hazard 5H No radioactive materials are located in or near Building 989, and no radioactive materials, other than negligible amounts of contamination, are located in or near Building 984 Fires associated with the diesel fuel supplies for the diesel generator could impact the complex electric power supply, but the loss of electric power to the complex is dominated by other electrical system failure modes Fires impacting backup power supplies would have little contribution to the overall frequency associated with complex loss of power Fires associated with the gasoline fuel supply for the drum crusher would be minor, due to the quantity of fuel associated with the drum crusher motor, and would only impact equipment in Building 984 Due to the location of the fuel supplies relative to any sources of radioactive material and the frequency dominance of other initiators dealing with loss of electric power over fires in the diesel generator building, the combustible material hazard associated with the diesel fuel (gasoline) storage tank combustibles is considered a **Standard Industrial Hazard** and will not be further evaluated Interactions of the hazard with activities are shown in Table 54

Table 54 Diesel Fuel (Gasoline) Storage Tank Combustibles Hazard Activity Interaction

	ACTIVITY							
INTERACTION	CHEM	CON	GEN	MAINT	SNM	WASTE	RA	SURV
Operates/Uses/Manipulates/Moves			yes	may			yes	
Maintains/Repairs				yes				
Inspects/Tests								yes

Protective features credited in the determination that diesel fuel storage tank combustibles are a Standard Industrial Hazard are shown in Table 55

Table 55 Diesel Fuel (Gasoline) Storage Tank Combustibles Hazard Protective Features

- ISSUE	APPLICABLE	GENERAL FEATURE FUNCTION	CREDITED GENERAL FEATURES
Mechanical Interaction	no		
Chemical Interaction	no		
Thermal Interaction	yes	Maintenance of tank barriers Separation from hazardous materials Separation from ignition sources	System maintenance [MAINT] Current configuration control [CONFIG, EPWM] Hot work control [FIRE]
Worker Safety	yes	Physical barriers Protective equipment Administrative	Separate facility, locked facility [CONFIG ORG] none System inspection/monitoring, maintenance work evaluation, work control, postings, training [S&IH, ORG, MAINT, WORK, TRAIN]

<u>Floor Loading (Sub-hazard 13E)</u>

The mission for Building 991 in the Building 991 Complex has changed significantly from its original design purpose The potential exists that the storage of waste containers up to a fourth tier could exceed the design loading of the floor if the original design was developed for floor loads that are significantly lower than current, drum storage loads The failure of the floor due to waste container loads could result in (1) exposure of pyrophoric waste metal to atmosphere with subsequent fires due to container breach, (2) spill of container contents following container falls, and (3) rearrangement of containers with subsequent criticality events due to container displacement and collection in floor collapse region

Waste container storage has already occurred in the facility with no evidence that the floor load capacity is being exceeded (*i e*, no cracking of the floor) However, the full capacity and subsequent floor loading of the facility has not been realized up to this point Also, the existing basement open areas are located under hallways rather than under waste storage locations There has been speculation that the original design of the facility included basement rooms that could be located under the waste storage areas Due to the uncertainty associated with the load capacity of the floor in Building 991, the floor loading hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Combustibles (Sub-hazard 13F)

Part of the operation of the Building 991 Complex will include the introduction, staging, use, and storage of various combustible materials Examples of combustibles that may be located in the facilities at various times include (1) wooden pallets from the receipt of empty waste drums for the drum crusher activity, (2) wooden waste crates (flame retardant wood) to be staged as empties or stored containing LLW, (3) combustible/flammable liquids stored in fire rated cabinets or in other containers for use by tenant activities (*e g*, developer and fixer solutions to be used by NDT activities), (4) construction materials (*e g*, scaffolding), and (5) general Office Area combustibles (*e g*, furniture, paper, plastics) The presence of combustibles does not necessarily present an immediate hazard but combustible loading in a facility can increase the consequences associated with fires and potentially can lead to facility fire initiation if placed near ignition sources Waste container storage areas are not generally used for the accumulation or storage of combustible materials but transient combustibles may be temporarily located in these areas, and non-waste storage area combustible loading and subsequent fires may impact contiguous waste storage areas The combustibles hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Natural Phenomena or External Event Induced Fires (Sub-hazard 13G)

The Building 991 Complex will contain various combustible materials and ignition sources during operation of the facility It is possible that natural phenomena or external events can result in facility fires by impacting the combustibles and ignition sources Seismic events may result in natural gas line failure (mobile flammable material travels to an ignition source), electric power system short circuits (ignition source that can act on nearby combustibles), or breach of flammable liquid containers (mobile flammable material travels to an ignition source) that subsequently leads to a fire Lightning (a natural phenomena ignition source) may result in electric power system short circuits (ignition source that can act on nearby combustibles) or may act directly on combustibles that can lead to a fire Aircraft crash external events can directly lead to a fire as a result of the aircraft fuel and heated materials involved in the crash Range fires impacting vegetation near the facility can directly lead to fire impacting external combustibles near the facilities The natural phenomena or external event induced fires hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Natural Phenomena or External Event Induced Spills (Sub-hazard 13H)

The Building 991 Complex will contain radioactive materials during operation of the facility It is possible that natural phenomena or external events can result in spills and punctures of the radioactive material containers (with subsequent material fires or criticalities) by directly or indirectly impacting the containers Seismic events may result in toppling stacked waste containers, debris impacts on containers from ceiling component failures (*e g*, lighting, ducting, cranes) during the seismic event, or structure impacts on containers from seismic-induced facility

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collapse that subsequently leads to a spill or puncture High winds, tornadoes, and heavy snow may result in structure impacts on containers from partial facility collapse due to the loss of a load bearing wall (*i e*, static load from wind exceeds design capacity of a wall) or due to the failure of the roof (*i e*, static load of the snow exceeds design capacity of the roof) that subsequently leads to a spill or puncture In addition, tornadoes may result in debris impacts on containers by tornado-driven missiles that subsequently leads to a spill or puncture Heavy rains, flooding (internal or external), and freezing induced internal flooding may result in toppling stacked waste containers (*i e*, flowing water during flood carries debris that impacts stacked containers) or structure impacts on containers from partial facility collapse due to the loss of a load bearing wall (*i e*, waters erode soils near wall footings) that subsequently leads to a spill or puncture Aircraft crash external events may result in toppling stacked waste containers, debris impacts on containers from aircraft parts, or structure impacts on containers from partial facility collapse due to the aircraft penetration of a load bearing wall that subsequently leads to a spill or puncture The natural phenomena or external event induced spills hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Natural Phenomena or External Event Induced Explosions (Sub-hazard 13I)

The Building 991 Complex will contain potentially explosive materials and potentially explosive waste containers during operation of the facility It is possible that natural phenomena or external events can result in facility explosions (with subsequent material fires or criticalities) by releasing potentially explosive materials Seismic events and aircraft crash external events may result in natural gas line failure (release of potentially explosive material) due to failure of line or boiler supports or failure of any flammable gas containers used by the facility (*i e*, propane gas cylinders used during construction or maintenance activities) due to structural impacts from facility failure or from aircraft debris High winds, tornadoes, and heavy snows may result in structure impacts on flammable gas containers used by the facility (*i e*, propane gas cylinders used during construction or maintenance activities) from partial facility collapse due to the loss of a load bearing wall (*i e*, static load from wind exceeds design capacity of a wall) or due to the failure of the roof (*i e*, dynamic load from wind/tornado or static load of the snow exceeds design capacity of the roof) that subsequently leads to an explosion In addition, high winds or tornadoes may result in debris impacts on natural gas lines or boilers by wind/tornado-driven missiles that subsequently leads to a release of the gas Lightning (a natural phenomena ignition source) may act directly on potentially explosive materials (*i e*, striking natural gas lines or propane cylinders) that can lead to an explosion The natural phenomena or external event induced explosions hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

Natural Phenomena or External Event Induced Criticalities (Sub-hazard 13J)

The Building 991 Complex will contain radioactive materials during operation of the facility It is possible that natural phenomena or external events can result in criticalities (with subsequent spills or material fires) by rearranging radioactive material containers Seismic events and aircraft crash external events may result in toppling stacked waste containers, rearranging the container configurations, that subsequently leads to a criticality Heavy snows may result in structural failures leading to toppling stacked waste containers, rearranging the

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container configurations, that subsequently leads to a criticality Heavy rains, flooding (internal or external), and freezing induced internal flooding may result in toppling stacked waste containers (i e, flowing water during flood carries debris that impacts stacked containers), rearranging the container configurations and adding moderation (i e, water acts as a moderator) that subsequently leads to a criticality The natural phenomena or external event induced criticalities hazard is further evaluated and the activity interactions and protective features are identified in later sections of this report

4.1.12 Summary of Credited Protective Features For Standard Industrial Hazards

The hazard identification process identified 44 hazards or energy sources for the Building 991 Complex Of the 44 hazards, 22 hazards or energy sources were characterized as Standard Industrial Hazards that do not need to be carried forward for further hazard evaluation or analysis Protective features for these 22 hazards were identified and fall into two general classes (1) protective features to ensure that the hazard remains a Standard Industrial Hazard, termed Hazard Controls, and (2) protective features associated with worker protection against the Standard Industrial Hazard, termed Worker Controls Protective features placed in the Hazard Control class of protective features must be carried forward into the final control set specified in the Building 991 Complex Technical Safety Requirements (TSRs)

The identified protective features associated with each Standard Industrial Hazard were related to SMPs defined in Chapter 3, *Safety Management Programs*, of the FSAR Table 56 summarizes the protective features for each SMP and classifies the protective features as a Hazard Control or a Worker Control The hazards/energy sources crediting the protective feature are listed following each protective feature The Hazard Controls identified for a SMP precede the Worker Controls for the SMP in the table to allow for quick identification of protective features that need to be carried forward into the TSR control set For protective features that are classified as a Hazard Control, the table provides discussion about what Safety Analysis assumption is maintained by the credited protective feature

Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
ORG	Quantity control • General Industrial Chemicals, • Cupric Chloride	Hazard Control	Maintains assumptions of the Safety Analysis that the chemical hazards pose no risk to CW or public
	Source control • Sealed Sources	Worker Control	
	Device control • X-ray Device	Worker Control	
	System monitoring • Heated Water; • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Compressed Air, Compressors, • Rotating Machinery, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	
	Locked facility/doors • Diesel Generator, Day Tank, Batteries, • Unventilated Tunnels and Areas, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	
	Area restrictions • General Industrial Chemicals, • Asbestos, • Lead, • Unventilated Tunnels and Areas	Worker Control	
	Quantity control • Cupric Chloride	Worker Control	
	Area monitoring • Unventilated Tunnels and Areas	Worker Control	
	Current configuration control • Unventilated Tunnels and Areas	Worker Control	
CONFIG	Current configuration control a 13 8 kV Transformers, Heated Water, Electric Heaters, Diesel Generator, Day Tank, Batteries, Compressed Air, Compressors, Drum Crusher, Rotating Machinery, Overhead Cranes, Battery Charging Station, Diesel Fuel (Gasoline) Storage Tank Combustibles, b X-ray Device, c Heated Water, d Compressed Air, Compressors, e General Industrial Chemicals	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard a. remains separate from hazardous material, b remains remote from CW and public, c remains relatively low temperature, d remains relatively low pressure, e remains separate from radioactive materials
	Current configuration control • Diesel Generator, Day Tank, Batteries, • Cupric Chloride, • Asbestos, • Polychlorinated Biphenyls, • Lead • Unventilated Tunnels and Areas	Worker Control	
	Separate facility • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	

Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
EPWM	No container opening • Contamination	Hazard Control	Maintains assumptions of the Safety Analysis that no significant contamination hazards are expected
	Current configuration control a Heated Water; Electric Heaters, Diesel Generator, Day Tank, Batteries, Compressed Air, Compressors, Drum Crusher; Rotating Machinery, Overhead Cranes, General Industrial Chemicals, Battery Charging Station, Diesel Fuel (Gasoline) Storage Tank Combustibles, b Drum Crusher	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard a. remains separate from hazardous materials b remains exposed to limited radioactive material
	No container opening • Contamination	Worker Control	
	Current material form control • Beryllium	Worker Control	
	Container or Waste Container • Asbestos, • Polychlorinated Biphenyls, • Lead, • Batteries	Worker Control	
	Area surveys • Unventilated Tunnels and Areas	Worker Control	
FIRE	Combustible control • 13 8 kV Transformers, • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Battery Charging Station	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard remains separate from combustibles
	Hot work control • Diesel Fuel (Gasoline) Storage Tank Combustibles	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard remains separate from ignition sources
	System inspection • Electric Heaters, • Diesel Generator, Day Tank, Batteries	Worker Control	
S&IH	Source package • Sealed Sources	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard is contained in non-dispersible form
	Chemical package • General Industrial Chemicals	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard is contained in a standard package
	Quantity control • General Industrial Chemicals	Hazard Control	Maintains assumptions of the Safety Analysis that the chemical hazards pose no risk to CW or public
	Fenced area • 13 8 kV Transformers	Worker Control	
	Insulated enclosure/insulation • 13 8 kV Transformers, • Heated water	Worker Control	

Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
S&IH (continued)	Protective equipment {job/hazard specific} • 13 8 kV Transformers, • Heated Water, • Electric Heaters, • Diesel Generator, Day Tank, Batteries • Compressed Air, Compressors, • Drum Crusher, • Rotating Machinery & Tools, • General Industrial Chemicals, • Cupric Chloride, • Polychlorinated Biphenyls, • Lead, • Batteries, • Unventilated Tunnels and Areas, • Battery Charging Stations	Worker Control	
	Postings/labeling • 13 8 kV Transformers, • Sealed Sources, • X-ray Device, • Heated Water; • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Compressed Air, Compressors, • Rotating Machinery, • Overhead Cranes, • General Industrial Chemicals, • Cupric Chloride, • Asbestos, • Polychlorinated Biphenyls, • Lead, • Unventilated Tunnels and Areas, • Battery Charging Stations, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	
	Lockout/tagout • 13 8 kV Transformers, • Compressed Air, Compressors, • Rotating Machinery, • Overhead Cranes, • Battery Charging Stations	Worker Control	
	Source/chemical/component package • Sealed Sources, • General Industrial Chemicals, • Cupric Chloride, • Batteries	Worker Control	
	Shielding • Sealed Sources, • X-ray Device	Worker Control	
	Source/device inspection • Sealed Sources, • X-ray Device	Worker Control	
	Device/component • X-ray Device • Drum Crusher	Worker Control	
	Piping/components/relief valves/storage tanks • Heated Water • Compressed Air, Compressors, • Diesel Fuel (Gasoline)	Worker Control	

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Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
S&IH (continued)	System/component/tool inspection/ surveillance • Heated Water; • Electric Heaters, • Diesel Generator, Day Tank, Batteries • Compressed Air, Compressors, • Drum Crusher, • Rotating Machinery & Tools, • Overhead Cranes, • Batteries, • Battery Charging Stations, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	
	Elevation • Electric Heaters	Worker Control	
	Heater/component enclosures • Electric Heaters, • Rotating Machinery & Tools, • Battery Charging Stations	Worker Control	
	Speed governors • Rotating Machinery & Tools	Worker Hazard	
	Chemical inventory/quantity control • General Industrial Chemicals, • Cupric Chloride, • Diesel Fuel (Gasoline)	Worker Control	
	Area surveys/restrictions/locked doors • General Industrial Chemicals, • Cupric Chloride, • Asbestos, • Lead, • Unventilated Tunnels and Areas	Worker Control	
	Current material form/configuration control • Beryllium, • Asbestos, • Polychlorinated Biphenyls, • Lead	Worker Control	
MAINT	System maintenance a. Electric Heaters, b Diesel Generator, Day Tank, Batteries, Diesel Fuel (Gasoline) Storage Tank Combustibles	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard a. failure rate is low due to system insulation remaining in place, b containment remains in place
	Maintenance work evaluation • Rotating Tools	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard remains separated from hazardous materials
	Source use evaluation • Sealed Sources	Worker Control	
	Maintenance work evaluation • Contamination, • Heated Water, • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Compressed Air, Compressors • Drum Crusher, • Rotating Machinery & Tools, • Overhead Cranes, • General Industrial Chemicals • Asbestos, • Polychlorinated Biphenyls • Lead, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	

Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
QA	Source package quality • Sealed Sources	Worker Control	
RAD	Source package • Sealed Sources	Worker Control	
	Shielding • Sealed Sources, • X-ray Device	Worker Control	
	Protective equipment (job/hazard specific) • Sealed Sources, • X-ray Device, • Contamination	Worker Control	
	Source/device inspection • Sealed Sources, • X-ray Device	Worker Control	
	Postings • Sealed Sources, • X-ray Device, • Contamination	Worker Control	
	ALARA • Sealed Sources, • Contamination	Worker Control	
	Device • X-ray Device	Worker Control	
	Confinements • Contamination	Worker Control	
	Area surveys • Contamination	Worker Control	
	Radiation work permits • Contamination	Worker Control	
TRAIN	Training • 13 8 kV Transformers, • Sealed Sources, • X-ray Device, • Contamination, • Heated Water, • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Compressed Air, Compressors, • Drum Crusher, • Rotating Machinery & Tools, • Overhead Cranes, • General Industrial Chemicals, • Cupric Chloride, • Asbestos, • Polychlorinated Biphenyls, • Lead, • Batteries, • Diesel Fuel (Gasoline), • Unventilated Tunnels and Areas, • Battery Charging Stations, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	

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Table 56 Credited Protective Features for Standard Industrial Hazards

SMP	PROTECTIVE FEATURE	CLASSIFICATION	REMARKS FOR HAZARD CONTROLS
WORK	Work control • Rotating Tools	Hazard Control	Maintains assumptions of the Safety Analysis that the hazard remains separated from hazardous materials
	Work control • 13 8 kV Transformers, • Sealed Sources, • X-ray Device, • Contamination, • Heated Water, • Electric Heaters, • Diesel Generator, Day Tank, Batteries, • Compressed Air, Compressors, • Drum Crusher, • Rotating Machinery & Tools, • Overhead Cranes, • General Industrial Chemicals, • Cupric Chloride, • Asbestos, • Polychlorinated Biphenyls, • Lead, • Batteries, • Diesel Fuel (Gasoline), • Unventilated Tunnels and Areas, • Battery Charging Stations, • Diesel Fuel (Gasoline) Storage Tank Combustibles	Worker Control	

4.2 RADIOLOGICAL HAZARD CATEGORY DETERMINATION

The DOE has provided guidance on the determination of a nuclear facility Hazard Category in DOE-STD-1027-92 (Ref 3) The DOE Standard allows for the use of a facility inventory comparison to isotopic radiological thresholds, which are provided in the attachment to the Standard, to determine an initial nuclear facility Hazard Category The determination of a facility Hazard Category primarily focuses on the radiological material inventories of the facility but consideration must be given to other hazardous materials or hazardous operations

The Hazard Category of a nuclear facility is used, in part, to determine if the facility is exempt from the requirements of DOE Order 5480 23 (Ref 2) to develop a facility Safety Analysis Report (SAR) In addition, the nuclear facility Hazard Category can be used as one consideration in the Safety Analysis graded approach concept

The Building 991 Complex nuclear facility Hazard Category is initially determined using the isotopic radiological thresholds provided in the Standard The radiological isotopes of interest for the Building 991 Complex include (1) ^{239}Pu in WG Pu, (2) ^{241}Am in WG Pu and in higher concentrations associated with residue wastes, (3) ^{233}U in waste containers and Type B shipping containers, (4) ^{235}U in waste containers and Type B shipping containers, and (5) ^{238}U in waste containers and Type B shipping containers The corresponding isotopic radiological thresholds are presented in Table 57

Table 57 Hazard Category 2 and 3 Radiological Thresholds for Isotopes of Interest

	HAZARD CATEGORY 2 RADIOLOGICAL THRESHOLDS		HAZARD CATEGORY 3 RADIOLOGICAL THRESHOLDS	
ISOTOPE	ACTIVITY (Ci)	QUANTITY (g)	ACTIVITY (Ci)	QUANTITY (g)
^{233}U (criticality precluded)	220	23,000	4 2	440
^{233}U (criticality possible)	4 8	500	not applicable	not applicable
^{235}U (criticality precluded)	240	110,000,000	4 2	1,900,000
^{235}U (criticality possible)	0 0015	700	not applicable	not applicable
^{238}U	240	710,000,000	4 2	13,000,000
^{239}Pu (criticality precluded)	56	900	0 52	8 4
^{239}Pu (criticality possible)	28	450	not applicable	not applicable
^{241}Am	55	16	0 52	0 15

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The Building 991 Complex may handle waste containers with maximum radioactive material loadings as presented in Table 16 and Type B shipping containers with up to 6,000 grams of WG Pu The predominant radioactive materials that will be found in the Building 991 Complex are isotopes of plutonium blended with some americium rather than uranium Examination of Table 57 indicates that the gram quantity radiological thresholds for ^{239}Pu and ^{241}Am are less than comparable uranium isotope radiological thresholds in all cases In addition, the radiological consequences of uranium in Type B shipping containers or waste containers is bounded by equivalent containers of WG Pu For the above reasons, the container inventories of uranium isotopes are not of interest

Since the ^{239}Pu content of WG Pu is over 92% (see SARAH, Ref 8), Tables 16 and 57 would indicate that the upper bound WG Pu content of 5 TRU waste 55-gallon waste drums (approximately 920 grams of ^{239}Pu), 1 POC (approximately 1,155 grams of ^{239}Pu), 4 TRUPACT II SWB containers (approximately 1,180 grams of ^{239}Pu), or 4 metal waste boxes (approximately 1,180 grams of ^{239}Pu), would exceed the Hazard Category 2 threshold for ^{239}Pu, even if a criticality is precluded Since the Building 991 Complex can potentially store thousands of waste containers, the complex can be considered a Hazard Category 2 nuclear facility This categorization would be true even if the waste containers had inventories closer to LLW rather than the upper bound WG Pu content of TRU waste In addition, a single, worst case IDC (*i e*, highest americium content) POC would exceed the Hazard Category 2 threshold for americium

Due to the potential ^{239}Pu content and potential ^{241}Am content of the Building 991 Complex waste containers, the Building 991 Complex is considered a Hazard Category 2 nuclear facility based on exceeding the Hazard Category 2 radiological thresholds for both of the isotopes even though DOE-STD-1027-92 indicates that the inventory found in the Type B shipping containers does not have to be considered in the complex inventory

4.3 HAZARD EVALUATION

4.3.1 Hazard Evaluation Process and Initial Hazard Evaluation

As stated earlier, the hazard identification process identified 44 hazards or energy sources for the Building 991 Complex Of the 44 hazards, 22 hazards or energy sources were characterized as Standard Industrial Hazards that do not need to be carried forward for further hazard evaluation or analysis The remaining 22 hazards or energy sources are further evaluated using a hazard evaluation process prior to performing an accident analysis for the Building 991 Complex Table 58 presents the set of 22 hazards or energy sources from Table 8 that are to be considered in the hazard evaluation process The numerical codes associated with each hazard shown in Table 58 relate back to the general hazard category (*e g*, Radioactive Materials, Kinetic Energy) and the specific hazards under each category For example, Hazard 7A corresponds to specific hazard A, Vehicles, Material Handling Equipment, under general hazard category 7, Kinetic Energy

Table 58 Building 991 Complex Hazards and Energy Sources to be Further Analyzed

#	HAZARD / ENERGY SOURCE	#	HAZARD / ENERGY SOURCE
4A	Category I and II SNM	4B	Waste Containers
5B	Propane	5C	Natural Gas
5D	Pyrophoric Materials	5E	Electric Power System
5H	Transport Vehicles	6C	Pressurized Metal Waste Containers
7A	Vehicles, Material Handling Equipment	8B	Raised Loads on Forklifts
8C	Stacked Waste Containers	11A	Receipt and Shipment of Waste Containers at the Dock
11B	Receipt and Shipment of SNM Containers at the Dock	11C	Movement of Waste Containers in the Facility
13A	Hydrogen Generation in Metal Waste Containers	13C	Tunnel Degradation and Leakage
13E	Floor Loading	13F	Combustibles
13G	Natural Phenomena or External Event Induced Fires	13H	Natural Phenomena or External Event Induced Spills
13I	Natural Phenomena or External Event Induced Explosions	13J	Natural Phenomena or External Event Induced Criticalities

The hazards of most interest, in Table 58, are Hazard 4A, Category I and II SNM, and Hazard 4B, Waste Containers The remaining hazards and energy sources either act on these hazards (*e g*, Hazard 7A, Vehicles, Material Handling Equipment) or are subsets of these

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hazards (*e g*, Hazard 5D, Pyrophoric Materials) In support of the hazard evaluation process, logic diagrams, as described below, are developed displaying the manner in which each of the remaining hazards and energy sources act on Hazard 4A and Hazard 4B No chemical hazards are shown in Table 58 because chemicals are adequately controlled as Standard Industrial Hazards Therefore, it is not necessary to determine how other hazards and energy sources act on the chemicals While chemical releases are not further evaluated, many of the failure mechanisms, developed below, that result in radioactive material releases would apply to chemical releases

The radioactive material hazards are contained or confined in various SNM and waste containers The material has an increased hazard to the IW and is only a hazard to the CW and the public when it is released from its container due to a container failure or when a criticality involving the material occurs The criticality case can result in the release of radioactive material that is not currently found in the containers but is generated during the criticality event (*i e*, fission products) However, the criticality event can also result in container failure due to over-pressurization of the container Therefore, by identifying manners in which containers can fail, mechanisms for radioactive material release can be determined

Two classes of radioactive material containers are identified for assessment of failure mechanisms using logic diagrams (1) metal containers and (2) wooden containers Distinctions between these two classes of containers are made because some mechanisms for failure of the containers are different (*e g*, wooden containers can burn, metal containers can overpressurize) The logic diagrams for failures of metal containers and wooden containers are displayed in Figure 1 and Figure 2, respectively

Figure 1 and Figure 2 display a logical connection between the 20 applicable hazards and energy sources requiring further analysis (Hazard 4A and Hazard 4B are excluded) and container failure The far left of the logic diagram begins with failure of the container. The next events shown in the figures deal with a set of basic phenomenological mechanisms leading to failure It is assumed that no basic mechanisms for container failure exist other than (1) mechanically induced failure due to exterior events, (2) chemically induced failure due to interior and exterior events, (3) thermally induced failure due to interior and exterior events, and (4) overpressure induced failure due to interior and exterior events Intentional opening of containers leading to a release is not considered and is prohibited by Administrative Controls

Following each basic phenomenological mechanism, a series of more detailed mechanisms are identified out to one or more of the 20 hazards and energy sources (excluding 4A and 4B) from Table 58 Generally, a single hazard or multiple hazards are listed at the end of the logic path In some cases, two sets of hazards are listed and are separated by a plus sign, "+" In the two hazard set cases, the top set of hazards deals with a condition specification and the bottom set deals with an initiating event The natural phenomena and external event hazards are listed by specific event (*e g*, Seismic) rather than general event type (*e g*, Natural Phenomena or External Event Induced Spills) to aid in later analysis

Figure 1 applies to both Type B SNM shipping containers and metal waste containers unless specifically stated otherwise The following assumptions are made in the development of the logic diagram for metal container failure

(1) The Internal / Chemical Failure path was not analyzed because

- the chemical failure mechanism is relatively slow,
- highly corrosive materials inside waste containers will be prohibited without prior neutralization, and
- free liquids inside waste containers will be prohibited,

(2) The External / Chemical Failure path was not analyzed because

- the chemical failure mechanism is relatively slow,
- there is significant potential for discovery prior to failure, and
- highly corrosive liquids in container storage areas will be prohibited without full secondary containment of the liquid being in place,

(3) The Internal / Thermal Failure path was not analyzed because

- the internal fire must be sufficiently hot to melt through metal, and
- few combustibles associated with materials in radioactive material containers exist at the Site with sufficient combustion temperature to melt metal,

(4) The Facility Fire / Thermal Failure path only includes Propane because

- the external fire must be sufficiently hot to melt through metal,
- few combustion materials exist with sufficient temperature to melt metal, and
- the propane torch flame is assumed to directly impinge on the container in order to reach metal melting temperatures,

(5) The Chemical Fire / Rapid Rate / Internal / Overpressure Failure path was not developed because

- the chemical reaction must be sufficiently fast to generate significant quantities of gas rapidly ,
- few chemical reactions associated with materials in waste exist at the Site with significant fast gas generation capabilities, and
- incompatible chemicals inside waste containers will be prohibited

There are 28 paths through the logic diagram on Figure 1 Eight paths exist for the Mechanical Failure legs, one path exists for the Thermal Failure leg, and 19 paths exist for the Overpressure Failure leg (*i e*, 8 paths for Criticality, 8 paths for Material Fire (pyrophoric), and 3 other paths) All 20 hazards and energy sources are used in the figure

Figure 2 applies to LLW wooden waste crates The following assumptions are made in the development of the logic diagram for wooden container failure

(1) The Internal / Chemical Failure path was not analyzed because

- the chemical failure mechanism is relatively slow, and
- highly corrosive materials inside waste containers will be prohibited without prior neutralization,

(2) The External / Chemical Failure path was not analyzed because

- the chemical failure mechanism is relatively slow,
- there is significant potential for discovery prior to failure, and
- highly corrosive liquids in container storage areas will be prohibited without full secondary containment of the liquid being in place,

(3) The Internal / Thermal Failure path was not analyzed because

- there are a very limited number of LLW internal fire mechanisms,
- the predominant mission for the Building 991 Complex deals with TRU waste rather than LLW; and
- incompatible chemicals inside waste containers will be prohibited

(4) Overpressure Failure, Material Fire (pyrophoric), and Criticality are not applicable to LLW wooden containers because

- wooden containers are not sufficiently sealed to retain gases such that an overpressure failure can occur,
- LLW will not contain any pyrophoric material, and
- LLW cannot be configured in a manner to achieve a criticality

There are 9 paths through the logic diagram on Figure 2 Eight paths exist for the Mechanical Failure legs and one path exists for the Thermal Failure leg Fifteen of the 20 hazards and energy sources are used in the figure

A total of 37 paths to radioactive material container failure have been identified Each path ends in a set of hazards and/or energy sources from Table 8 These paths have intermediate terms that deal with the seven general types of accident scenarios listed in Table 7 Based on the information from the figures, the general types of accident scenarios associated with each hazard or energy source can be determined The results of that determination are shown in Table 8 under the "Remarks" column

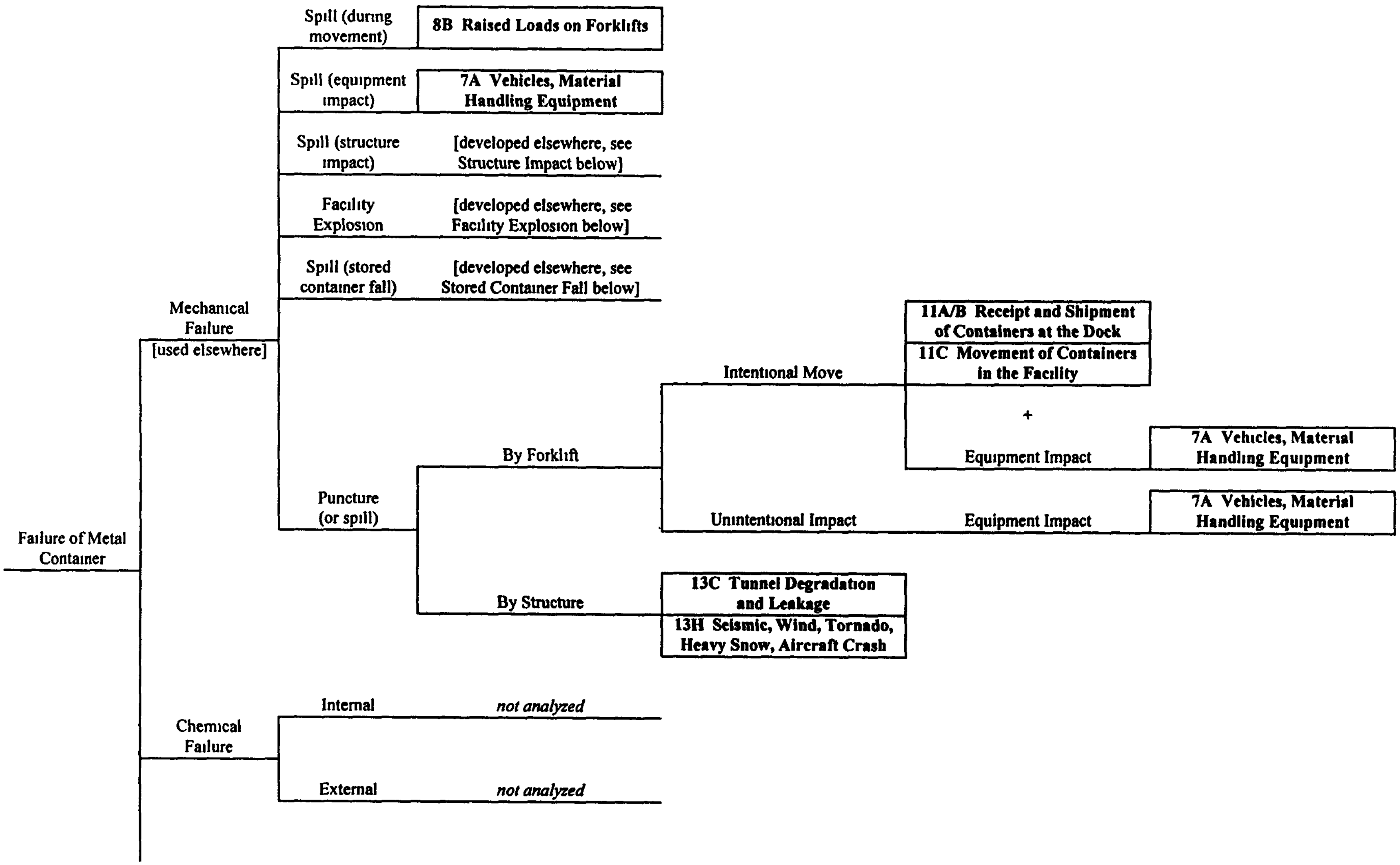

Figure 1 Relationship of Metal Container Failure Mechanisms to Facility Hazards

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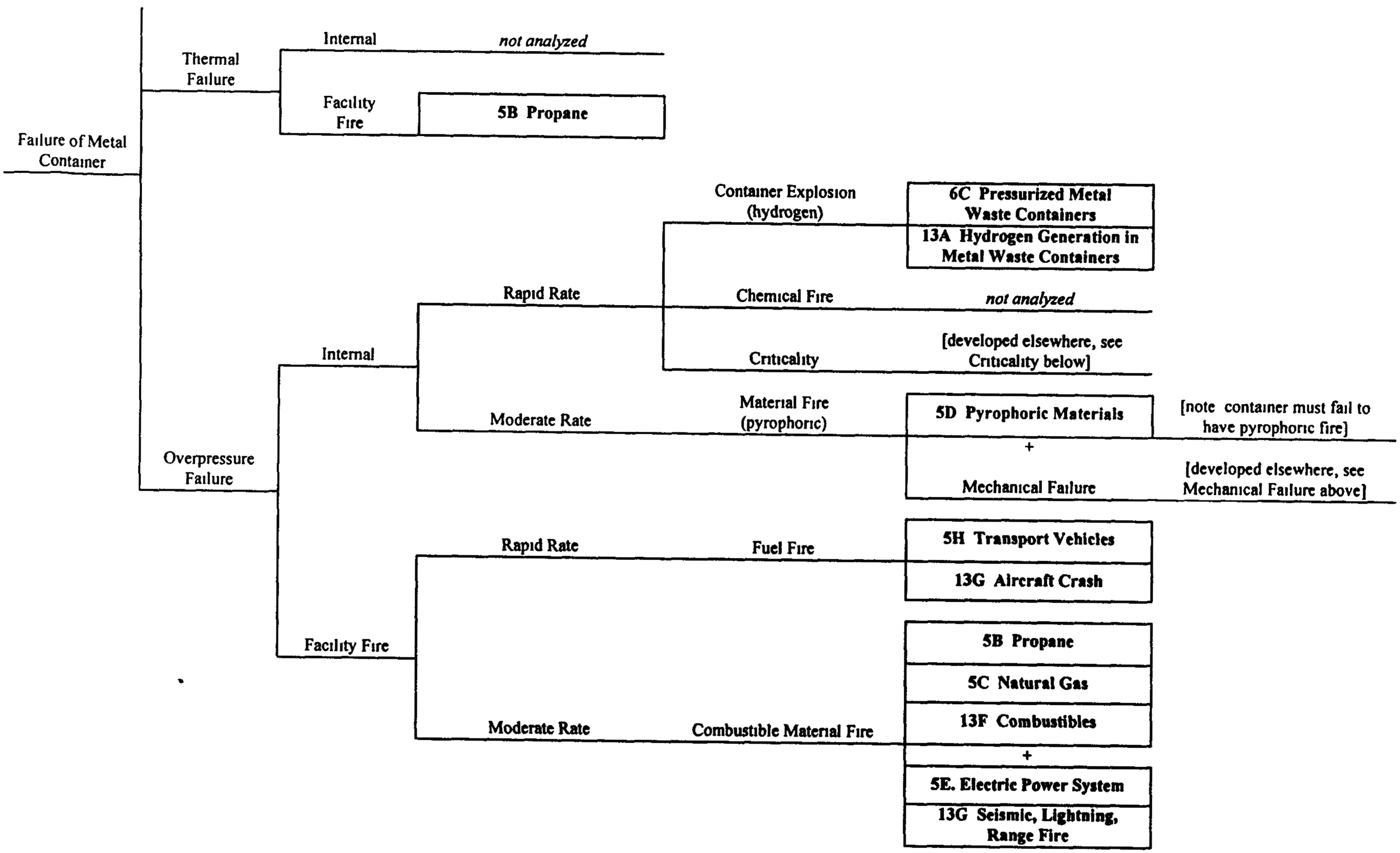

Figure 1 Relationship of Metal Container Failure Mechanisms to Facility Hazards

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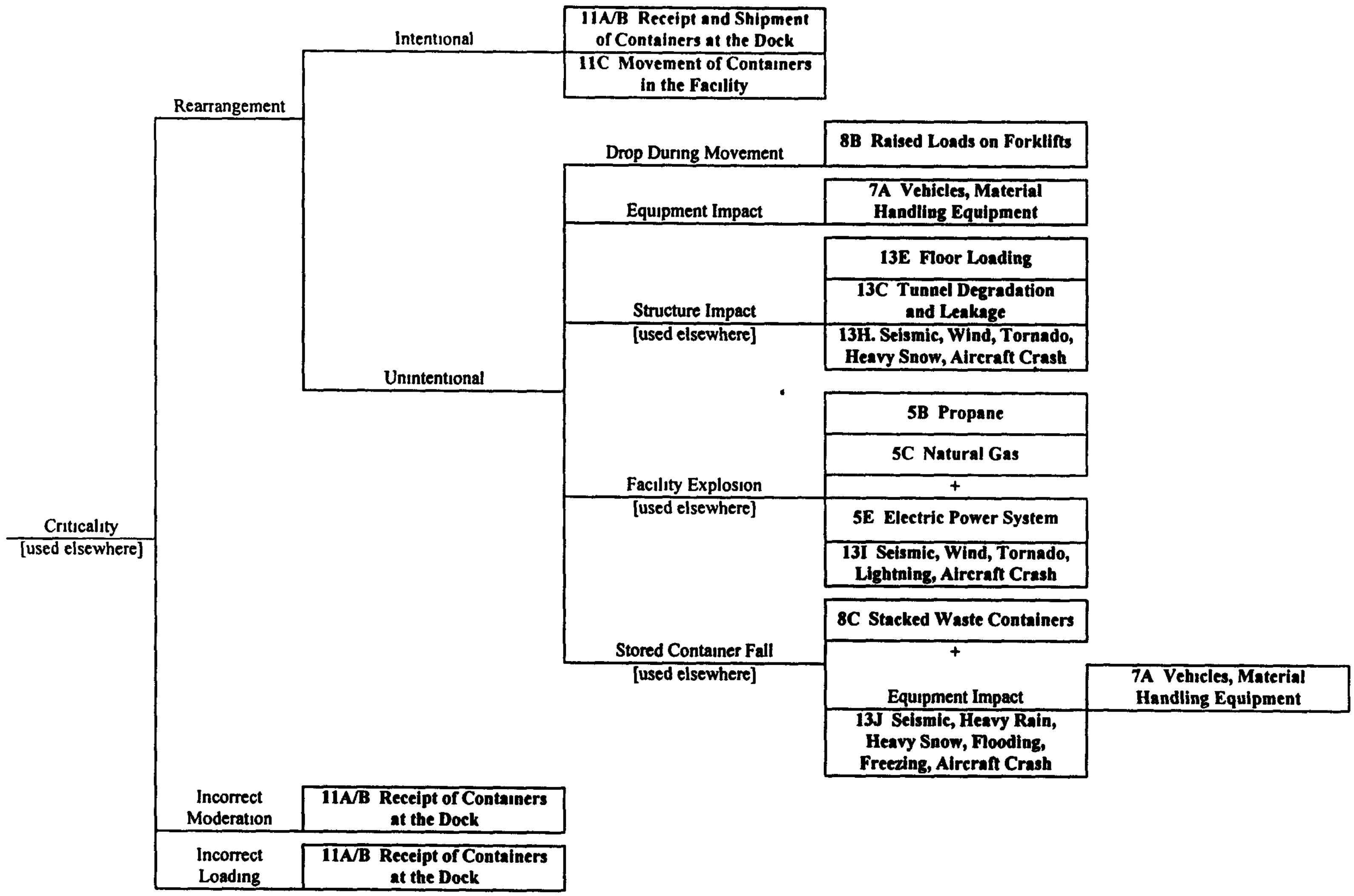

Figure 1 Relationship of Metal Container Failure Mechanisms to Facility Hazards

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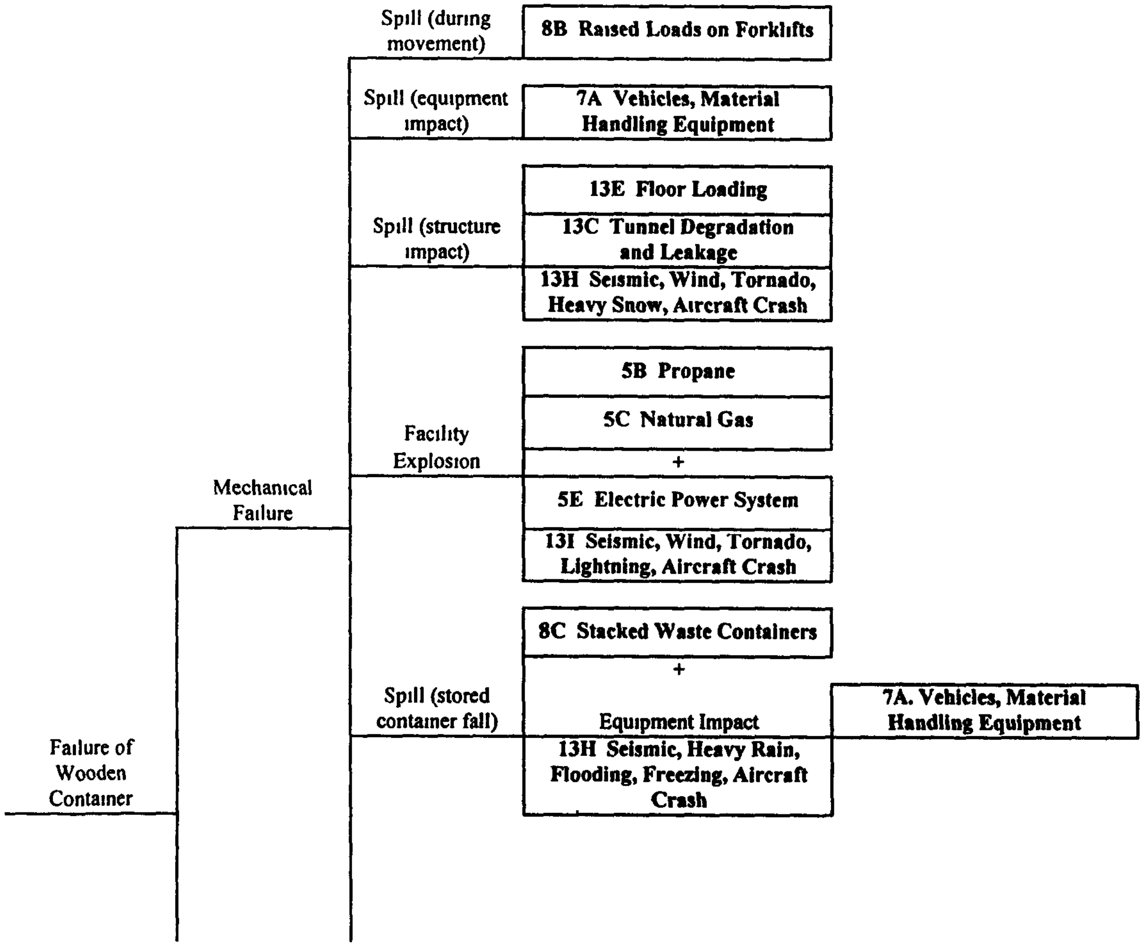

Figure 2 Relationship of Wooden Container Failure Mechanisms to Facility Hazards

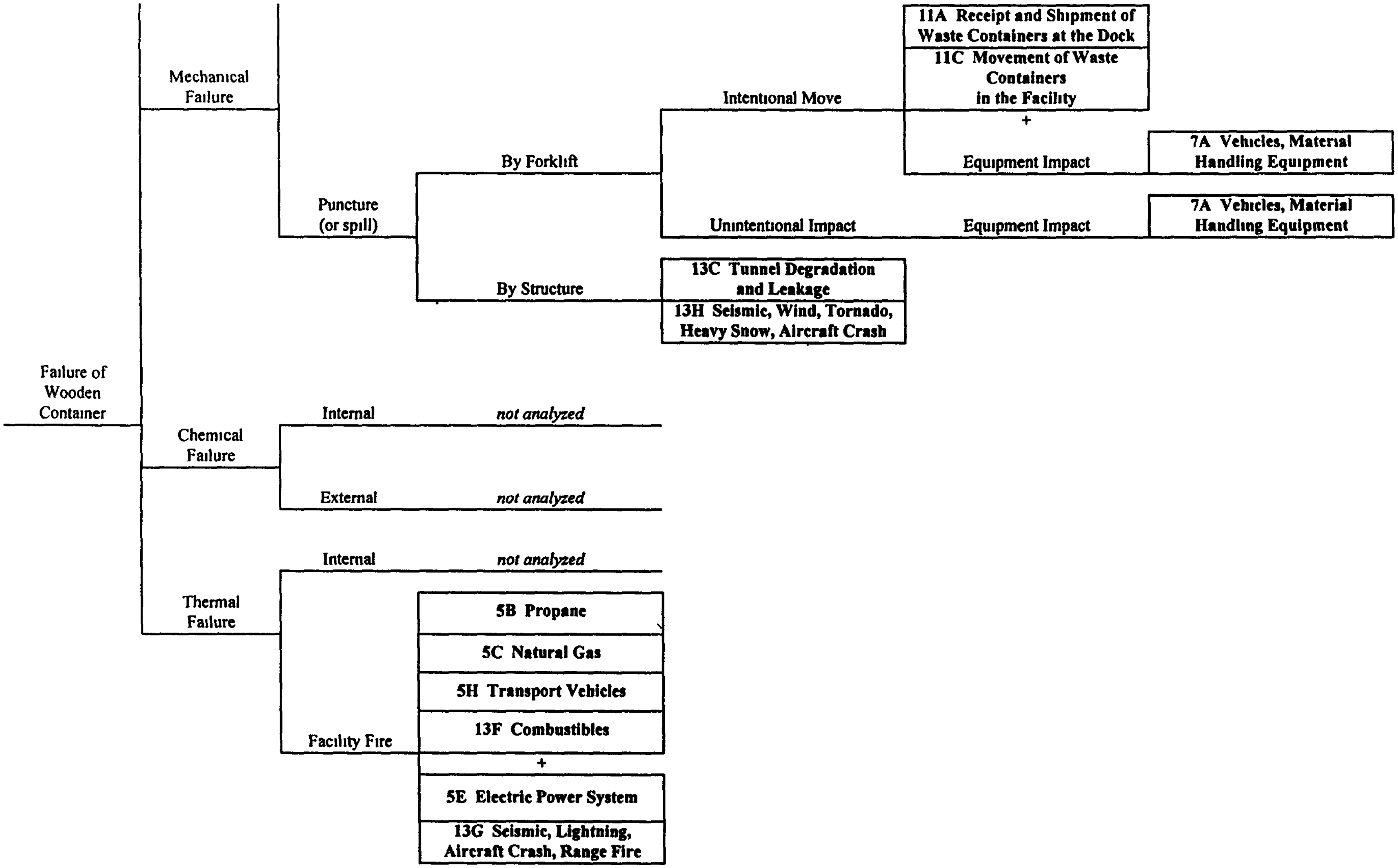

Figure 2 Relationship of Wooden Container Failure Mechanisms to Facility Hazards

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Having defined a relationship between facility hazards/energy sources and failure mechanisms of radioactive material containers, it is possible to begin release scenario development The approach taken for performing this hazard evaluation step considers the interaction of each logic path through Figure 1 and Figure 2 with Building 991 Complex activities A matrix is developed relating each initial scenario (*i e*, path through the logic diagrams) to each of the eight complex activities The matrix is presented in the form of a table that presents the hazard evaluation initial results Table 59 lists the 37 scenarios to be evaluated and provides an identification code for the scenario that will be used in later tables The order of scenario presentation in Table 59 follows the order of progression from the logic diagrams

Table 59 Scenarios to be Evaluated from Logic Diagrams

SCENARIO	DESCRIPTION	CODE
Spill Scenario 1	Metal container spill (during movement)	SPILL-1
Spill Scenario 2	Metal container spill (equipment impact)	SPILL-2
Spill Scenario 3	Metal container spill (structure impact)	SPILL-3
Facility Explosion Scenario 1	Metal container facility explosion	FEXPLO-1
Spill Scenario 4	Metal container spill (stored container fall)	SPILL-4
Puncture Scenario 1	Metal container puncture (forklift, intentional move)	PUNCT-1
Puncture Scenario 2	Metal container puncture (forklift impact)	PUNCT-2
Puncture Scenario 3	Metal container puncture (structure impact)	PUNCT-3
Facility Fire Scenario 1	Metal container facility fire (propane, direct flame exposure)	FFIRE-1
Container Explosion Scenario 1	Metal container explosion (hydrogen)	CEXPLO-1
Criticality Scenario 1	Metal container criticality (intentional move)	CRIT-1
Criticality Scenario 2	Metal container criticality (drop during movement rearrangement)	CRIT-2
Criticality Scenario 3	Metal container criticality (equipment impact rearrangement)	CRIT-3
Criticality Scenario 4	Metal container criticality (structure impact rearrangement)	CRIT-4
Criticality Scenario 5	Metal container criticality (facility explosion rearrangement)	CRIT-5
Criticality Scenario 6	Metal container criticality (stored container fall rearrangement)	CRIT-6
Criticality Scenario 7	Metal container criticality (incorrect moderation)	CRIT-7
Criticality Scenario 8	Metal container criticality (incorrect loading)	CRIT-8
Material Fire Scenario 1	Metal container material fire (container breach, during movement)	MFIRE-1
Material Fire Scenario 2	Metal container material fire (container breach, equipment impact)	MFIRE-2
Material Fire Scenario 3	Metal container material fire (container breach, structure impact)	MFIRE-3
Material Fire Scenario 4	Metal container material fire (container breach, facility explosion)	MFIRE-4
Material Fire Scenario 5	Metal container material fire (container breach, stored container fall)	MFIRE-5
Material Fire Scenario 6	Metal container material fire (container puncture, forklift, intentional move)	MFIRE-6
Material Fire Scenario 7	Metal container material fire (container puncture, forklift impact)	MFIRE-7
Material Fire Scenario 8	Metal container material fire (container puncture, structure impact)	MFIRE-8
Facility Fire Scenario 2	Metal container facility fire (fuel fire)	FFIRE-2

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Table 59 Scenarios to be Evaluated from Logic Diagrams

SCENARIO	DESCRIPTION	CODE
Facility Fire Scenario 3	Metal container facility fire (combustible material fire)	FFIRE-3
Spill Scenario 5	Wooden container spill (during movement)	SPILL-5
Spill Scenario 6	Wooden container spill (equipment impact)	SPILL-6
Spill Scenario 7	Wooden container spill (structure impact)	SPILL-7
Facility Explosion Scenario 2	Wooden container facility explosion	FEXPLO-2
Spill Scenario 8	Wooden container spill (stored container fall)	SPILL-8
Puncture Scenario 4	Wooden container puncture (forklift, intentional move)	PUNCT-4
Puncture Scenario 5	Wooden container puncture (forklift impact)	PUNCT-5
Puncture Scenario 6	Wooden container puncture (structure impact)	PUNCT-6
Facility Fire Scenario 4	Wooden container facility fire	FFIRE-4

The hazard evaluation table (Table 62) is composed of nine columns (*i e*, one column defining the scenario and one column for each of the eight activities) The type of information presented in each of the columns is described below

Column 1 - SCENARIO: This column defines the initial scenario being evaluated It presents each of the 37 scenarios or logic paths defined in Figure 1 and Figure 2 The scenario is placed into one of the seven types of accident scenarios defined in Table 7 and is given a numerical designation (*e g*, Spill Scenario 3) Assumptions dealing with scenario preliminary consequence bin assignments are also presented in the column (*i e*, unmitigated releases assuming worst case ARRF values for the accident scenario type, non-lofted plume, and 95[th] percentile χ/Q values for the CW are used to determine initial MAR thresholds for low and high consequence bins by assessing against the evaluation guidelines presented in Table 2)

Columns 2 and greater - BUILDING 991 COMPLEX ACTIVITY: These columns of the hazard evaluation table determine an initial risk class (using Table 1) for each scenario under the corresponding activity If a particular activity deals with multiple radioactive material containers (*e g*, WASTE deals with LLW crates/boxes, TRU waste drums, TRU waste boxes, and POCs), the activity column will address each type of container in the evaluation A likelihood of the scenario occurring under each activity is determined taking no credit for any radioactive material container integrity (*i e*, the likelihood that the activity will place a container at risk for the hazard being evaluated) Likelihood information is presented in terms of frequency bin assignments A likelihood of failure (*i e*, container failure) is then presented for each container covered by the activity by crediting container integrity Assumptions dealing with container integrity under various scenarios or other matters are presented separate from the hazard evaluation table A scenario potential MAR for each container covered by the activity is then developed using the information in Table 16 and Section 4 1 3, *Radioactive Materials*

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(*Hazard/Energy Source 4*) Based on the MAR thresholds for the scenario presented in the first column of the table, a scenario consequence bin assignment is made for each activity container Using the frequency bin assignment for container failure and the scenario consequence bin assignment, a scenario initial risk class is developed for each activity and corresponding containers using the Table 1 categorization scheme

Table 60 presents the basis for the MAR thresholds that are used in the first column of the hazard evaluation table The thresholds are based on staying below CW evaluation guidelines using worst case ARRF values for the accident scenario type, non-lofted plume, Solubility Class W and 95th percentile χ/Q values (referred to as "worst case" spills, fires, explosions) The "Comments" column of the table indicates which material form ARRF value is used as a worst case Facility explosion scenarios are initially assumed to lead to spill events and facility explosions use the MAR thresholds for spills

Table 60 Initial MAR Thresholds for Scenario Consequence Determination

SCENARIO TYPE	ARRF VALUE	LOW	HIGH	COMMENTS
Spill, Puncture, or Facility Explosion	0 001	< 3 18 grams	> 157 grams	unconfined combustible spill
Material Fire or Facility Fire	0 05	< 0 063 grams	> 3 1 grams	unconfined combustible fire
Container Explosion	0 001	< 3 18 grams	> 157 grams	overpressure release from container

Table 61 presents a listing of the general assumptions made (coded by the letter "G" and applicable to an unspecified set of scenarios), assumptions made (coded by the letter "A"), the protective features credited (coded by the letter "F"), and requirements specified (coded by the letter "R") in the development of the hazard evaluation table The "General Assumptions" category covers assumptions made in the Safety Analysis that initially do not apply to specific accident scenarios (*i e*, apply to many or all scenarios) versus the "Assumptions" category that applies to a few specific accident scenarios Except for the general assumptions, the scenarios to which each assumption, feature, or requirement applies are listed in the table along with the impact of the assumption, feature, or requirement Table 62 and Table 63 present the hazard evaluation tables The hazard evaluation table was divided into two tables to support presentation The first table deals with Building 991 Complex activities that deal directly with radioactive materials (*i e*, GEN, SNM, WASTE, and SURV) The second table deals with the remaining activities (*i e*, CHEM, CON, MAINT, and RA) The codes for the assumptions, credited protective features, or requirements from Table 61 are presented in the hazard evaluation table in each place that a "Likelihood of scenario" entry is not *Anticipated* and in each place that a "Likelihood of failure" entry is not equivalent to the "Likelihood of scenario" entry (*i e*, those places where something is credited to reduce the event likelihood) The Table 61 codes follow

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directly after the likelihood designation and a brief explanation is presented after the code In contrast, the general assumptions made in the development of the hazard evaluation table are not specifically identified in the tables for applicable situations

Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G1	LLW generated under the GEN activity has negligible contamination and will yield *low* consequences in all cases	not specified	Sets the potential consequences for many GEN activity scenarios
G2	LLW containers contain no more than 0 5 grams (WG Pu equivalent) in metal drums and 3 grams in wooden or metal boxes	not specified	Sets the potential MAR for many scenarios impacting LLW containers (3 grams for spills, punctures, and criticality potential)
G3	Assumption deleted Rev 1		
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	not specified	Sets the potential MAR for many scenarios impacting waste containers (200 grams for facility fires and container explosions, 320 grams for facility fires, spills, punctures, container explosions, and criticality potential)
G5	A pallet of TRU waste drums contains no more than 4 drums and only 2 drums can be impacted by forklift tines	not specified	Sets the potential MAR for many scenarios impacting pallets of waste containers (800 grams for pallet spills, material fires, and criticality potential, 400 grams for pallet punctures and material fires)
G6	POC containers contain no more than 1,255 grams (WG Pu equivalent) in metal drums and 200 grams (fissile material) in metal drums	not specified	Sets the potential MAR for many scenarios impacting POC containers (1,255 grams for facility fires and container explosions)
G7	A pallet of POC drums contains no more than 4 drums and only 1 drum can be impacted by forklift tines	not specified	Sets the potential MAR for many scenarios impacting pallets of POC containers (5,020 grams for pallet spills, 1,255 grams for punctures, 800 grams for criticality potential)

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G8	Type B containers cannot be impacted by activities other than the SNM and SURV activities due to their storage location and safeguards restrictions	not specified	Defines the potential interactions and corresponding types of containers for many scenarios
G9	Type B containers are assumed to contain 6,000 grams (WG Pu equivalent) of oxide	not specified	Sets the potential MAR for many scenarios impacting Type B containers (6,000 grams for facility fires, spills, punctures, and criticality potential)
G10	Type B containers containing pyrophoric material are assumed to contain 2,000 grams (WG Pu equivalent) of metal	not specified	Sets the potential MAR for many scenarios impacting Type B pyrophoric material containers (2,000 grams for material fires)
G11	Type B shipping containers, POC containers, and TRU waste containers will not be opened in the Building 991 Complex	not specified	Defines the potential interactions for many scenarios
A1	The CHEM, CON, GEN, MAINT, and SURV activities require a very limited amount of container movements	SPILL-1-A/D/E/F/G SPILL-2-A/D/E/F/G PUNCT-1-A/D/E/F/G CRIT-1-A/D/E/F/G CRIT-2-A/D/E/F/G CRIT-3-A/D/E/F/G MFIRE-1-D/E/F/G MFIRE-2-D/E/F/G MFIRE-6-D/E/F/G SPILL-5-A/D/E/F/G SPILL-6-A/D/E/F/G PUNCT-4-A/D/E/F/G	Reduces the likelihood of some direct interaction scenarios dealing with container movements, other than container explosion scenarios, by one frequency bin

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A2	Damaging high winds and heavy snows are *anticipated* events except over vaults, damaging lightning strikes are *anticipated* events, freezing events impacting the complex are *anticipated*, damaging heavy rains and flooding are *unlikely* events, facility collapse due to seismic events is *unlikely* except for below ground vaults, damaging tornadoes are *unlikely* events, damaging range fires are *extremely unlikely* events	SPILL-3-A/B/C PUNCT-3-A/B/C CRIT-4-A/B/C MFIRE-3-B/C MFIRE-8-B/C SPILL-7-A/C PUNCT-6-A/C	Sets the likelihood of natural phenomena events
A3	Damaging tunnel failure and floor loading failures are *unlikely* events, damaging aircraft crashes are *extremely unlikely* events	SPILL-3-A/B/C PUNCT-3-A/B/C CRIT-4-A/B/C MFIRE-3-B/C MFIRE-8-B/C SPILL-7-A/C PUNCT-6-A/C	Sets the likelihood of some internal and external events
A4	Natural gas system failure leading to an explosion impacting the facility is an *extremely unlikely* event	FEXPLO-1-A/C CRIT-5-A/C FEXPLO-2-A/C	Sets the likelihood for facility explosion events
A5	Vault areas are not expected to be impacted by facility explosions involving natural gas	FEXPLO-1-B CRIT-5-B MFIRE-4-B	Reduces the likelihood of container failure, for containers located in vaults, from scenarios dealing with natural gas explosions to *Beyond Extremely Unlikely*
A6	The CHEM, CON, GEN, MAINT, RA, and SURV activities perform limited operations with material handling equipment	SPILL-4-A/D/E/F/G/H PUNCT-2-A/D/E/F/G/H CEXPLO-1-A/E/F/G/H CRIT-6-A/D/E/F/G/H MFIRE-7-A/D/E/F/G/H SPILL-8-A/D/E/F/G/H PUNCT-5-A/D/E/F/G/H	Reduces the likelihood of some indirect interaction scenarios dealing with material handling equipment impacts on other activity containers by one frequency bin

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A7	Due to the limited amount of waste generation under GEN and the expected locations for the activity, direct exposure of the waste container to propane or other flammable gases is considered to be a *beyond extremely unlikely* event	FFIRE-1-A	Reduces the likelihood of GEN activity waste container failure from scenarios dealing with direct exposure to flammable gases (*i e*, torches) to *Beyond Extremely Unlikely*
A8	The SNM activity performs operations with material handling equipment in proximity to metal waste containers but is *unlikely* to interact with hydrogen generating waste drums	CEXPLO-1-B	Reduces the likelihood of indirect interaction scenarios dealing with material handling equipment impacts on other activity hydrogen generating containers by one frequency bin
A9	At least 10 kilograms of plutonium oxide are required to yield a criticality involving waste material (Ref 32)	CRIT-1-A CRIT-2-A/C/D/E/F/G CRIT-3-A/C/D/E/F/G CRIT-4-A/C CRIT-5-A/C/F/G CRIT-6-A/B/C/D/E/F/G/H	Reduces the likelihood of criticalities from scenarios dealing with less than 10 kilograms of plutonium contaminated waste to *Beyond Extremely Unlikely*
A10	Pyrophoric materials (e g , uranium fines) are not introduced into the facility under the WASTE activity	MFIRE-1-C/D/E/F/G MFIRE-2-C/D/E/F/G MFIRE-3-C MFIRE-4-C/F/G MFIRE-5-A/C/D/E/F/G/H MFIRE-6-C/D/E/F/G MFIRE-7-A/B/C/D/E/F/G/H MFIRE-8-C	Reduces the likelihood of pyrophoric material waste container scenarios to *Beyond Extremely Unlikely*
A11	Assumption deleted Rev 1		
A12	Transport vehicle fires are *unlikely* events	FFIRE-2-A/B/C	Sets the likelihood of the event
A13	Due to the limited amount of waste generation under GEN and the expected locations for the activity, exposure of the waste container to transport vehicle fires is considered to be an *unlikely* event	FFIRE-2-A	Reduces the likelihood of GEN activity waste container exposure to scenarios dealing with transport vehicle fires by one frequency bin

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A14	Due to the lower likelihood that transport vehicle fires deal with the diesel fuel on the vehicle and the protection afforded by the cargo bed of the trailer, transport vehicle fire propagation to waste containers is an *unlikely* event	FFIRE-2-A/C	Reduces the likelihood of waste container failure from scenarios dealing with transport vehicle fires by one frequency bin
F1	Type B shipping containers cannot be breached by falls from any heights expected during operation	SPILL-1-B/D CRIT-2-B/D MFIRE-1-B/D	Reduces the likelihood of Type B shipping container failure from scenarios dealing with dropped containers to *Beyond Extremely Unlikely*
F2	POC containers cannot be breached by falls from any heights expected during operation	SPILL-1-C/D/E/F/G SPILL-4-A/B/C/D/E/F/G/H	Reduces the likelihood of POC container failure from scenarios dealing with dropped containers to *Beyond Extremely Unlikely*
F3	Metal waste containers are *unlikely* to be breached by non-forklift tine impacts from material handling equipment expected during operation	SPILL-2-A/C/D/E/F/G MFIRE-2-C/D/E/F/G	Reduces the likelihood of metal waste container failure for scenarios dealing with material handling equipment impacts with containers, other than forklift tine puncture scenarios, by one frequency bin
F4	Type B shipping containers cannot be breached by material handling equipment impacts expected during operation	SPILL-2-B/D CRIT-3-B/D MFIRE-2-B/D	Reduces the likelihood of Type B shipping container failure from scenarios dealing with material handling equipment impacts with containers to *Beyond Extremely Unlikely*
F5	POC containers cannot be breached by material handling equipment impacts expected during operation	SPILL-2-C/D/E/F/G	Reduces the likelihood of POC container failure from scenarios dealing with material handling equipment impacts with containers to *Beyond Extremely Unlikely*
F6	Type B shipping containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	SPILL-3-B PUNCT-3-B CRIT-4-B MFIRE-3-B MFIRE-8-B	Reduces the likelihood of Type B shipping container failure for scenarios dealing with structural members impacting containers by one frequency bin

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F7	POC containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	SPILL-3-C PUNCT-3-C CRIT-4-C	Reduces the likelihood of POC container failure for scenarios dealing with structural members impacting containers by one frequency bin
F8	Type B shipping containers cannot be breached by any external flammable gas explosions expected during operation	FEXPLO-1-B CRIT-5-B MFIRE-4-B	Reduces the likelihood of Type B shipping container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely*
F9	POC containers cannot be breached by any external flammable gas explosions expected during operation	FEXPLO-1-C/F/G CRIT-5-C/F/G	Reduces the likelihood of POC container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely*
F10	Metal waste containers are *unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and waste packaging	PUNCT-1-A/C/D/E/F/G PUNCT-2-A/B/C/D/E/F/G/H MFIRE-6-C/D/E/F/G MFIRE-7-A/B/C/D/E/F/G/H	Reduces the likelihood of metal waste container failure for scenarios dealing with forklift tines impacting containers by one frequency bin
F11	Type B shipping containers are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and SNM packaging	PUNCT-1-B/D MFIRE-6-B/D	Reduces the likelihood of Type B shipping container failure for scenarios dealing with forklift tines impacting containers by two frequency bins
F12	POC containers are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and waste packaging	PUNCT-1-C/D/E/F/G PUNCT-2-A/B/C/D/E/F/G/H	Reduces the likelihood of POC container failure for scenarios dealing with forklift tines impacting containers by two frequency bins
F13	Metal waste containers are *extremely unlikely* to be breached by internal hydrogen explosions due to metal waste container venting	CEXPLO-1-A/B/C/D/E/F/G/H	Reduces the likelihood of metal waste container failure for scenarios dealing with internal hydrogen explosions by two frequency bins

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Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F14	POC containers cannot be breached by any potential internal hydrogen explosions	CEXPLO-1-C/D	Reduces the likelihood of POC container failure from scenarios dealing with internal hydrogen explosions to *Beyond Extremely Unlikely*
F15	Type B shipping containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	FFIRE-2-B FFIRE-3-B	Reduces the likelihood of Type B shipping container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely*
F16	POC containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	FFIRE-2-C FFIRE-3-C/E/F/G/H	Reduces the likelihood of POC container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely*
F17	Flammable gas containers are *unlikely* to be breached during use	FEXPLO-1-F/G CRIT-5-F/G FFIRE-3-F/G FEXPLO-2-F/G FFIRE-4-F/G	Reduces the likelihood of explosion or fire scenarios due to use of flammable gases by one frequency bin
R1	Stacking of Type B shipping containers is prohibited	SPILL-4-B CRIT-6-B MFIRE-5-B	Reduces the likelihood of Type B shipping container spills associated with stack toppling to *Beyond Extremely Unlikely*
R2	Propane or other flammable gases are prohibited from vaults while SNM is present	FFIRE-1-B	Reduces the likelihood of Type B shipping container breaches associated with direct flame impingement from torches to *Beyond Extremely Unlikely*
R3	Work controls are required to ensure that waste container direct exposure to propane or other flammable gas flames is an *extremely unlikely* event	FFIRE-1-C/F/G	Reduces the likelihood of metal waste container failure from scenarios dealing with direct exposure to flammable gases (*i e*, torches) to *Extremely Unlikely*
R4	Type B shipping containers shall be designed and used in a manner to preclude a criticality as long as the containers remain intact	CRIT-1-B/D CRIT-2-B/D CRIT-3-B/D CRIT-7-B CRIT-8-B	Reduces the likelihood of intact Type B shipping container criticalities to *Beyond Extremely Unlikely*

Table 61 Assumptions/Credited Features/Requirements in Hazard Evaluation Tables

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R5	Waste containers in the Building 991 Complex shall be designed and used in a manner to preclude a criticality as long as the containers remain intact	CRIT-1-C/D/E/F/G CRIT-7-C CRIT-8-C	Reduces the likelihood of intact waste container criticalities to *Beyond Extremely Unlikely*
R6	Requirement deleted Rev 1		
R7	Requirement deleted Rev 1		
R8	A combustible material and ignition source control program shall be implemented to make fires in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	FFIRE-3-A/B/C/E/F/G/H FFIRE-4-A/C/E/F/G/H	Reduces the likelihood of facility fires potentially impacting radioactive material to *Unlikely*
R9	A hot work control program shall be implemented to make flammable gas explosions in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	FEXPLO-1-F/G CRIT-5-F/G FEXPLO-2-F/G	Reduces the likelihood of facility explosions potentially impacting radioactive material by one frequency bin
R10	Type B shipping containers received at Building 991 shall meet the requirements of 1-W89-HSP-31 11	MFIRE-3-B MFIRE-6-B/D MFIRE-8-B	Reduces the likelihood of a Type B shipping container containing pyrophoric material to *unlikely*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Spill Scenario 1</u> Failure of Metal Container Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>SPILL-1-A</u> **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste box can fail due to drop) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-1-B</u> **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F1] (Type B container cannot be breached by short drops) **Scenario Potential MAR** 24,000 grams (Type B pallet) **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	<u>SPILL-1-C</u> **Likelihood of scenario** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Anticipated* (metal waste drums / boxes can fail due to drop) *Beyond Extremely Unlikely* [F2] (POC container cannot be breached by short drops) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence·** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class·** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	<u>SPILL-1-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to drop) *Beyond Extremely Unlikely* (see [F1] for Type B container, see [F2] for POC container) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet), 24,000 grams (Type B pallet) **Scenario Consequence** *none* (Type B/POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (Type B/POC), *Risk Class III* (LLW), *Risk Class I* (TRU)

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Spill Scenario 2</u> Failure of Metal Container, Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>SPILL-2-A</u> **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F3] (metal waste box unlikely to fail from vehicle impact except under special conditions) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class IV*	<u>SPILL-2-B</u> **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [F4] (Type B container cannot be breached by vehicle impact) **Scenario Potential MAR:** 24,000 grams (Type B pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	<u>SPILL-2-C</u> **Likelihood of scenario:** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Unlikely* [F3] (metal waste drums / boxes unlikely to fail from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F5] (POC container cannot be breached by vehicle impact) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence:** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	<u>SPILL-2-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F3] (metal waste drums / boxes unlikely to fail from vehicle impact except under special conditions) *Beyond Extremely Unlikely* (see [F4] for Type B container, see [F5] for POC container) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet), 24,000 grams (Type B pallet) **Scenario Consequence** *none* (Type B/POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (Type B/POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Spill Scenario 3 Failure of Metal Container, Mechanical Failure, Spill (structure impact), **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-3-A **Likelihood of scenario.** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (metal waste box can fail due to structure impacts) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-3-B **Likelihood of scenario·** *Unlikely* [A2/A3] (seismic total collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F6] (Type B container unlikely to fail due to structural impacts) **Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class II*	SPILL-3-C **Likelihood of scenario** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (metal waste drums / boxes can fail due to structure impacts) *Unlikely* [F7] (POC container unlikely to fail due to structural impacts) **Scenario Potential MAR** inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *Moderate* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class** *Risk Class I*	SPILL-3-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Facility Explosion Scenario 1 Failure of Metal Container, Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **131 Seismic, Wind, Tornado, Lightning, Aircraft Crash** evaluated as a worst case container explosion [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**FEXPLO-1-A** **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* (metal waste box can fail due to external explosions) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class IV*	**FEXPLO-1-B** **Likelihood of scenario** *Beyond Extremely Unlikely* [A5] (vault not expected to be impacted by any identified events) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F8] (Type B container cannot be breached by external flammable gas explosions) **Scenario Potential MAR·** inventory of Type B containers **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	**FEXPLO-1-C** **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* (metal waste drums / boxes can fail due to external explosions) *Beyond Extremely Unlikely* [F9] (POC container cannot be breached by external flammable gas explosions) **Scenario Potential MAR·** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *Moderate* (LLW), *High* (TRU) **Scenario Initial Risk Class.** *not credible* (POC), *Risk Class III* (LLW), *Risk Class II* (TRU)	**FEXPLO-1-D** **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure·** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Spill Scenario 4</u> Failure of Metal Container, Mechanical Failure, Spill (stored container fall), **8C Stacked Waste Containers plus 7A Vehicles, Material Handling Equipment or 13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**<u>SPILL-4-A</u>** **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	**<u>SPILL-4-B</u>** **Likelihood of scenario** *Anticipated* [R1] (activity does not stack containers but vehicle, material handling equipment use by activity can impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Anticipated* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence·** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	**<u>SPILL-4-C</u>** **Likelihood of scenario** *Anticipated* (placement of waste containers in stacks may yield toppling of other stacks) [direct interaction] **Likelihood of failure:** *Anticipated* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence·** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	**<u>SPILL-4-D</u>** **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use required by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Puncture Scenario 1 Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A/B Receipt and Shipment of Containers at the Dock** or **11C Movement of Containers in the Facility** plus **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	PUNCT-1-A **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste box unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class.** *Risk Class IV*	PUNCT-1-B **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F11] (Type B container extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 6,000 grams (Type B) **Scenario Consequence·** *High* **Scenario Initial Risk Class:** *Risk Class II*	PUNCT-1-C **Likelihood of scenario·** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Extremely Unlikely* [F12] (POC container extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence:** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class·** *Risk Class III* (LLW), *Risk Class II* (POC), *Risk Class I* (TRU)	PUNCT-1-D **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* (see [F11] for Type B container, see [F12] for POC container) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC), 6,000 grams (Type B) **Scenario Consequence·** *none* (Type B/POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (Type B/POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Puncture Scenario 2</u> Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-2-A</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not involve much container movement but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class·** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	<u>PUNCT-2-B</u> **Likelihood of scenario·** *Anticipated* (activity does not involve much movement around susceptible SNM containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence·** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class** *Risk Class III* (LLW), *Risk Class II* (POC), *Risk Class I* (TRU)	<u>PUNCT-2-C</u> **Likelihood of scenario** *Anticipated* (placement of waste containers in stacks may yield impact with other stored containers) [direct interaction] **Likelihood of failure** *Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR·** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class** *Risk Class III* (LLW), *Risk Class II* (POC), *Risk Class I* (TRU)	<u>PUNCT-2-D</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)

Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
Puncture Scenario 3 Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Structure, **13C Tunnel Degradation and Leakage** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**	PUNCT-3-A **Likelihood of scenario** *Anticipated* [A2/A3] (high wind induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (metal waste box can be punctured due to structural member impact)	PUNCT-3-B **Likelihood of scenario** *Unlikely* [A2/A3] (seismic induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F6] (Type B container unlikely to puncture from structural member impact except under special conditions)	PUNCT-3-C **Likelihood of scenario** *Anticipated* [A2/A3] (high wind induced structural failure dominates) [indirect interaction] **Likelihood of failure**· *Anticipated* (metal waste drums / boxes can be punctured due to structural member impact) *Unlikely* [F7] (POC container unlikely to puncture from structural member impact except under special conditions)	PUNCT-3-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable
evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	**Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *High* **Scenario Initial Risk Class**· *Risk Class II*	**Scenario Potential MAR**· room inventory of LLW, TRU waste, and POC containers **Scenario Consequence:** *Moderate* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class** *Risk Class I*	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Facility Fire Scenario 1 Failure of Metal Container, Thermal Failure, Facility Fire, **5B Propane** evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	FFIRE-1-A **Likelihood of scenario:** *Beyond Extremely Unlikely* [A7] (propane use by other activities but limited time of exposure) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* (metal waste box can fail due to direct exposure to flammable gas flame) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	FFIRE-1-B **Likelihood of scenario** *Beyond Extremely Unlikely* [R2] (propane use by other activities but vault not expected to be impacted while SNM is present) [indirect interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* (Type B container can fail due to direct exposure to flammable gas flame) **Scenario Potential MAR:** 6,000 grams (Type B) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	FFIRE-1-C **Likelihood of scenario** *Extremely Unlikely* [R3] (propane use by other activities but difficult to directly impact stored container) [indirect interaction] **Likelihood of failure:** *Extremely Unlikely* (metal waste drums / boxes and POC containers can fail due to direct exposure to flammable gas flame) **Scenario Potential MAR:** 3 grams (LLW box), 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence:** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class:** *Risk Class IV* (LLW), *Risk Class II* (TRU/POC)	FFIRE-1-D **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR:** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Container Explosion</u> **<u>Scenario 1</u>** Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Container Explosion (hydrogen), **6C Pressurized Metal Waste Containers** or **13A Hydrogen Generation in Metal Waste Containers**	**<u>CEXPLO-1-A</u>** **Likelihood of scenario:** *Unlikely* [A6] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting)	**<u>CEXPLO-1-B</u>** **Likelihood of scenario:** *Unlikely* [A8] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure.** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting)	**<u>CEXPLO-1-C</u>** **Likelihood of scenario** *Anticipated* (contact with and movement of sealed metal waste containers may generate spark) [direct interaction] **Likelihood of failure:** *Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) *Beyond Extremely Unlikely* [F14] (POC container cannot be breached by internal hydrogen explosion)	**<u>CEXPLO-1-D</u>** **Likelihood of scenario** *Anticipated* (contact with sealed metal waste containers may generate spark) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) *Beyond Extremely Unlikely* [F14] (POC container cannot be breached by internal hydrogen explosion)
<u>evaluated as a worst case container explosion</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Potential MAR** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**Scenario Potential MAR** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**Scenario Potential MAR:** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class II* (TRU)	**Scenario Potential MAR** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class II* (TRU)

Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
<u>Criticality Scenario 1</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Intentional, **11A/B Receipt and Shipment of Containers at the Dock or 11C Movement of Containers in the Facility** <u>evaluated as a minimal criticality [see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-1-A</u> **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR·** contamination < 3 grams (LLW box) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-1-B</u> **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R4] (intact Type B containers cannot be arranged to yield a criticality due to Criticality Safety Requirements and container design) **Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class.** *not credible*	<u>CRIT-1-C</u> **Likelihood of scenario·** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR** inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-1-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* (see [R4] for Type B container, see [R5] for metal waste containers) **Scenario Potential MAR** inventory of Type B, LLW, TRU waste, and POC containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Criticality Scenario 2</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Drop During Movement, **8B Raised Loads on Forklifts** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-2-A</u> **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-2-B</u> **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [F1/R4] (Type B container cannot be breached by short drops) (intact Type B containers cannot be arranged to yield a criticality due to Criticality Safety Requirements and container design) **Scenario Potential MAR:** 24,000 grams (Type B pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class:** *not credible*	<u>CRIT-2-C</u> **Likelihood of scenario** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR:** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class:** *not credible*	<u>CRIT-2-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* (see [A9] for metal waste containers, see [F1/R4] for Type B containers) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet), 24,000 grams (Type B pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Criticality Scenario 3 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Equipment Impact, **7A Vehicles, Material Handling Equipment** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-3-A **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *none* **Scenario Initial Risk Class·** *not credible*	CRIT-3-B **Likelihood of scenario·** *Anticipated* (multiple movements of Type B containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F4/R4] (Type B container cannot be breached by vehicle impact) (intact Type B containers cannot be arranged to yield a criticality due to Criticality Safety Requirements and container design) **Scenario Potential MAR** 24,000 grams (Type B pallet) **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	CRIT-3-C **Likelihood of scenario** *Anticipated* (multiple movements of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-3-D **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* (see [A9] for metal waste containers, see [F4/R4] for Type B containers) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet), 24,000 grams (Type B pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
Criticality Scenario 4 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Structure Impact, **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-4-A **Likelihood of scenario** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence**· *none* **Scenario Initial Risk Class** *not credible*	CRIT-4-B **Likelihood of scenario**· *Unlikely* [A2/A3] (seismic total collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F6] (Type B container unlikely to fail due to structural impacts) **Scenario Potential MAR:** inventory of Type B containers **Scenario Consequence**· *High* **Scenario Initial Risk Class**· *Risk Class II*	CRIT-4-C **Likelihood of scenario** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure**· *Anticipated* (metal waste drums / boxes can fail due to structure impacts) *Unlikely* [F7] (POC container unlikely to fail due to structural impacts) *Beyond Extremely Unlikely* [A9] (insufficient MAR in LLW to generate a criticality) **Scenario Potential MAR** inventory of LLW, TRU waste, and POC containers **Scenario Consequence**· *none* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class:** *not credible* (LLW), *Risk Class I* (TRU/POC)	CRIT-4-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR.** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Criticality Scenario 5</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **13I Seismic, Wind, Tornado, Lightning, Aircraft Crash** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-5-A</u> **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-5-B</u> **Likelihood of scenario:** *Beyond Extremely Unlikely* [A5] (vault not expected to be impacted by any identified events) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F8] (Type B container cannot be breached by external flammable gas explosions) **Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class:** *not credible*	<u>CRIT-5-C</u> **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* (metal waste drums / boxes can fail due to external explosions) *Beyond Extremely Unlikely* [A9/F9] (insufficient MAR in LLW to generate a criticality) (POC container cannot be breached by external flammable gas explosions) **Scenario Potential MAR.** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence:** *none* (LLW/POC), *High* (TRU) **Scenario Initial Risk Class** *not credible* (LLW/POC), *Risk Class II* (TRU)	<u>CRIT-5-D</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Criticality Scenario 6 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Stored Container Fall, **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13J Seismic, Heavy Rain, Heavy Snow, Flooding, Freezing, Aircraft Crash** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-6-A **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR:** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-6-B **Likelihood of scenario** *Anticipated* [R1] (activity does not stack containers but vehicle, material handling equipment use by activity can impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	CRIT-6-C **Likelihood of scenario:** *Anticipated* (placement of waste containers in stacks may yield toppling of other stacks) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR:** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class:** *not credible*	CRIT-6-D **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use required by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Criticality Scenario 7 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Incorrect Moderation, **11A/B Receipt of Containers at the Dock** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-7-A **Likelihood of scenario** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-7-B **Likelihood of scenario** *Anticipated* (multiple receipts of Type B containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R4] (intact Type B containers cannot be arranged to yield a criticality due to Criticality Safety Requirements and container design) **Scenario Potential MAR·** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-7-C **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR:** dock inventory of LLW, TRU waste, and POC containers **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	CRIT-7-D **Likelihood of scenario** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Criticality Scenario 8 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Incorrect Loading, **11A/B Receipt of Containers at the Dock** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-8-A **Likelihood of scenario** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence:** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-8-B **Likelihood of scenario** *Anticipated* (multiple receipts of Type B containers) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [R4] (intact Type B containers cannot be arranged to yield a criticality due to Criticality Safety Requirements and container design) **Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class:** *not credible*	CRIT-8-C **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR:** dock inventory of LLW, TRU waste, and POC containers **Scenario Consequence:** *none* **Scenario Initial Risk Class:** *not credible*	CRIT-8-D **Likelihood of scenario** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Material Fire Scenario 1</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts**] <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>**MFIRE-1-A**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>**MFIRE-1-B**</u> **Likelihood of scenario** *Anticipated* (multiple movements of Type B containers containing pyrophoric material) [direct interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [F1] (Type B container cannot be breached by short drops) **Scenario Potential MAR** 8,000 grams (Type B, metal) **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	<u>**MFIRE-1-C**</u> **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>**MFIRE-1-D**</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) *Beyond Extremely Unlikely* [F1] (Type B container cannot be breached by short drops) **Scenario Potential MAR** none (TRU) 8,000 grams (Type B, metal) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Material Fire Scenario 2</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	<u>MFIRE-2-A</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction]	<u>MFIRE-2-B</u> **Likelihood of scenario:** *Anticipated* (multiple movements of Type B containers containing pyrophoric material) [direct interaction]	<u>MFIRE-2-C</u> **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [direct interaction]	<u>MFIRE-2-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction]
Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment**]	**Likelihood of failure.** not applicable	**Likelihood of failure·** *Beyond Extremely Unlikely* [F4] (Type B container cannot be breached by vehicle impact)	**Likelihood of failure** *Beyond Extremely Unlikely* [F3/A10] (metal waste drums unlikely to fail from vehicle impact) (pyrophoric materials are not introduced into the facility)	**Likelihood of failure:** *Beyond Extremely Unlikely* [F3/A10/F4] (metal waste drums unlikely to fail from vehicle impact) (pyrophoric materials are not introduced into the facility) (Type B container cannot be breached by vehicle impact)
	Scenario Potential MAR not applicable	**Scenario Potential MAR** 8,000 grams (Type B, metal)	**Scenario Potential MAR** none	**Scenario Potential MAR** none (TRU) 8,000 grams (Type B, metal)
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence** not applicable	**Scenario Consequence:** *none*	**Scenario Consequence·** *none*	**Scenario Consequence** *none*
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not credible*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
<u>Material Fire Scenario 3</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	<u>MFIRE-3-A</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	<u>MFIRE-3-B</u> **Likelihood of scenario·** *Unlikely* [A2/A3] (seismic total collapse of facility dominates)	<u>MFIRE-3-C</u> **Likelihood of scenario** *Unlikely* [A2/A3] (seismic total collapse of facility dominates)	<u>MFIRE-3-D</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)
Material Fire (pyrophoric),	[no interaction]	[indirect interaction]	[indirect interaction]	[no interaction]
5D Pyrophoric Materials plus [Mechanical Failure, Spill (structure impact), **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**]	**Likelihood of failure** not applicable	**Likelihood of failure** *Beyond Extremely Unlikely* [F6/R10] (Type B container unlikely to fail due to structural impacts) (Type B container unlikely to be non-compliant with 1-W89-HSP-31 11 requirements)	**Likelihood of failure** *Beyond Extremely Unlikely* [A10] (metal waste drums can fail due to structure impacts exposing pyrophoric material) (pyrophoric materials are not introduced into the facility)	**Likelihood of failure** not applicable
	Scenario Potential MAR not applicable	**Scenario Potential MAR** inventory of Type B containers	**Scenario Potential MAR·** none	**Scenario Potential MAR** not applicable
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence** not applicable	**Scenario Consequence** *none*	**Scenario Consequence** *none*	**Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
<u>Material Fire Scenario 4</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **131 Seismic, Wind, Tornado, Lightning, Aircraft Crash**]	<u>MFIRE-4-A</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction] **Likelihood of failure** not applicable	<u>MFIRE-4-B</u> **Likelihood of scenario:** *Beyond Extremely Unlikely* [A5] (vault not expected to be impacted by any identified events) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F8] (Type B container cannot be breached by external flammable gas explosions)	<u>MFIRE-4-C</u> **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [indirect interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [A10] (metal waste drums can fail due to external explosions exposing pyrophoric material) (pyrophoric materials are not introduced into the facility)	<u>MFIRE-4-D</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction] **Likelihood of failure** not applicable
	Scenario Potential MAR not applicable	**Scenario Potential MAR** inventory of Type B containers	**Scenario Potential MAR.** none	**Scenario Potential MAR** not applicable
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence** not applicable	**Scenario Consequence** *none*	**Scenario Consequence·** *none*	**Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Material Fire Scenario 5 Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric),	MFIRE-5-A **Likelihood of scenario** *Anticipated* (waste containers will be stacked in the facility)	MFIRE-5-B **Likelihood of scenario:** *Beyond Extremely Unlikely* [R1] (Type B shipping containers expected to remain in single planar arrays)	MFIRE-5-C **Likelihood of scenario** *Anticipated* (waste containers will be stacked in the facility)	MFIRE-5-D **Likelihood of scenario** *Beyond Extremely Unlikely* [A10/R1] (pyrophoric materials are not introduced into the facility) (Type B shipping containers expected to remain in single planar arrays)
5D Pyrophoric Materials plus [Mechanical Failure, Spill (stored container fall), **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash**]	[indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility)	[direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R1] (Type B shipping containers expected to remain in single planar arrays)	[direct interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility)	[indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) [R1] (Type B shipping containers expected to remain in single planar arrays)
	Scenario Potential MAR none	**Scenario Potential MAR·** inventory of containers containing pyrophoric material	**Scenario Potential MAR** none	**Scenario Potential MAR** inventory of containers containing pyrophoric material
evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	**Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	**Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	GEN	SNM	WASTE	SURV
	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
<u>Material Fire Scenario 6</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	<u>MFIRE-6-A</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	<u>MFIRE-6-B</u> **Likelihood of scenario.** *Anticipated* (multiple movements of Type B containers containing pyrophoric material)	<u>MFIRE-6-C</u> **Likelihood of scenario·** *Anticipated* (multiple receipts of waste containers)	<u>MFIRE-6-D</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity)
Material Fire (pyrophoric),	[no interaction]	[direct interaction]	[direct interaction]	[direct interaction]
5D Pyrophoric Materials plus [Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A/B Receipt and Shipment of Containers at the Dock** or **11C Movement of Containers in the Facility** plus **7A Vehicles, Material Handling Equipment**]	**Likelihood of failure** not applicable	**Likelihood of failure** *Beyond Extremely Unlikely* [F11/R10] (Type B container extremely unlikely to puncture from vehicle impact) (Type B container unlikely to be non-compliant with 1-W89-HSP-31 11 requirements)	**Likelihood of failure·** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility)	**Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) *Beyond Extremely Unlikely* [F11/R10] (Type B container extremely unlikely to puncture from vehicle impact) (Type B container unlikely to be non-compliant with 1-W89-HSP-31 11 requirements)
	Scenario Potential MAR· not applicable	**Scenario Potential MAR** 2,000 grams (Type B, metal)	**Scenario Potential MAR·** none	**Scenario Potential MAR** none (TRU) 2,000 grams (Type B, metal)
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	**Scenario Consequence** *none* **Scenario Initial Risk Class·** *not credible*	**Scenario Consequence** *none* **Scenario Initial Risk Class·** *not credible*	**Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Material Fire Scenario 7 Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment]** evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	MFIRE-7-A **Likelihood of scenario** *Unlikely* [A6] (GEN activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure.** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	MFIRE-7-B **Likelihood of scenario·** *Anticipated* (multiple receipts of waste containers but activity does not involve much movement around susceptible SNM containers) [indirect interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	MFIRE-7-C **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	MFIRE-7-D **Likelihood of scenario** *Unlikely* [A6] (SURV activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Material Fire Scenario 8 Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Puncture (or spill), By Structure, **13C Tunnel Degradation and Leakage** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**] evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	MFIRE-8-A **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR.** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	MFIRE-8-B **Likelihood of scenario** *Unlikely* [A2/A3] (seismic induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F6/R10] (Type B container unlikely to puncture from to structural member impact except under special conditions) (Type B container unlikely to be non-compliant with 1-W89-HSP-31 11 requirements) **Scenario Potential MAR·** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	MFIRE-8-C **Likelihood of scenario·** *Unlikely* [A2/A3] (seismic induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	MFIRE-8-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials) [no interaction] **Likelihood of failure·** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Facility Fire Scenario 2 Failure of Metal Container, Overpressure Failure, Facility Fire, Rapid Rate, Fuel Fire, **5H Transport Vehicles** or **13G Aircraft Crash** evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	FFIRE-2-A **Likelihood of scenario** *Extremely Unlikely* [A12/A13] (transport vehicle fire dominates but limited exposure to in-process containers) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A14] (propagation of vehicle fire to containers is unlikely) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *none* **Scenario Initial Risk Class**· *not credible*	FFIRE-2-B **Likelihood of scenario** *Unlikely* [A12] (transport vehicle fires dominate) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F15] (Type B container cannot be breached by external fires) **Scenario Potential MAR** inventory of Type B containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	FFIRE-2-C **Likelihood of scenario** *Unlikely* [A12] (transport vehicle fires dominate) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [A14] (propagation of vehicle fire to containers is unlikely) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR** transport vehicle inventory of LLW, TRU waste, and POC containers **Scenario Consequence**· *none* (POC), *High* (LLW/TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class II* (LLW/TRU)	FFIRE-2-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage or transport) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Facility Fire Scenario 3</u> Failure of Metal Container, Overpressure Failure, Facility Fire, Moderate Rate, Combustible Material Fire, **5B Propane** or **5C Natural Gas** or **13F Combustibles** plus **5E Electric Power System** or **13G Seismic, Lightning, Range Fire**	<u>FFIRE-3-A</u> **Likelihood of scenario** *Unlikely* [R8] (combustibles fire dominates) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste box can fail due to external fire) **Scenario Potential MAR** contamination < 3 grams (LLW box)	<u>FFIRE-3-B</u> **Likelihood of scenario.** *Unlikely* [R8] (combustibles fire dominates) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F15] (Type B container cannot be breached by external fires) **Scenario Potential MAR** inventory of Type B containers	<u>FFIRE-3-C</u> **Likelihood of scenario** *Unlikely* [R8] (combustibles fire dominates) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to external fire) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR** area inventory of LLW, TRU waste, and POC containers	<u>FFIRE-3-D</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable
	Scenario Consequence *Low*	**Scenario Consequence** *none*	**Scenario Consequence** *none* (POC), *High* (LLW/TRU)	**Scenario Consequence** not applicable
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Initial Risk Class** *Risk Class III*	**Scenario Initial Risk Class** *not credible*	**Scenario Initial Risk Class** *not credible* (POC), *Risk Class I* (LLW/TRU)	**Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
Spill Scenario 5 Failure of Wooden Container Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-5-A **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure·** *Unlikely* (wooden waste box can fail due to drop) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-5-B **Likelihood of scenario·** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	SPILL-5-C **Likelihood of scenario** *Anticipated* (multiple movements of wooden waste containers) [direct interaction] **Likelihood of failure** *Anticipated* (wooden waste boxes can fail due to drop) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-5-D **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to drop) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Spill Scenario 6 Failure of Wooden Container Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-6-A **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste box can fail due to vehicle impact) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-6-B **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure:** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	SPILL-6-C **Likelihood of scenario** *Anticipated* (multiple movements of wooden waste containers) [direct interaction] **Likelihood of failure** *Anticipated* (wooden waste boxes can fail due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-6-D **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	SNM	WASTE	SURV
Spill Scenario 7 Failure of Wooden Container Mechanical Failure, Spill (structure impact), **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-7-A **Likelihood of scenario** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (wooden waste box can fail due to structure impacts) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	SPILL-7-B **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR·** not applicable **Scenario Consequence·** not applicable **Scenario Initial Risk Class·** *not applicable*	SPILL-7-C **Likelihood of scenario** *Anticipated* [A2/A3] (high wind collapse of facility dominates) [indirect interaction] **Likelihood of failure·** *Anticipated* (wooden waste box can fail due to structure impacts) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence·** *Moderate* **Scenario Initial Risk Class·** *Risk Class I*	SPILL-7-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Facility Explosion Scenario 2</u> Failure of Wooden Container Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **131 Seismic, Wind, Tornado, Lightning, Aircraft Crash** <u>evaluated as a worst case container explosion</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**<u>FEXPLO-2-A</u>** **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* (wooden waste box can fail due to external explosions) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class IV*	**<u>FEXPLO-2-B</u>** **Likelihood of scenario·** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	**<u>FEXPLO-2-C</u>** **Likelihood of scenario** *Extremely Unlikely* [A4] (seismic impact on natural gas, activity not related to propane use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* (wooden waste box can fail due to external explosions) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *Moderate* **Scenario Initial Risk Class** *Risk Class III*	**<u>FEXPLO-2-D</u>** **Likelihood of scenario:** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Spill Scenario 8</u> Failure of Wooden Container, Mechanical Failure, Spill (stored container fall),	<u>SPILL-8-A</u> **Likelihood of scenario.** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity)	<u>SPILL-8-B</u> **Likelihood of scenario** *Anticipated* (activity does not stack containers but vehicle, material handling equipment use by activity can impact stored containers from WASTE activity)	<u>SPILL-8-C</u> **Likelihood of scenario** *Anticipated* (placement of waste containers in stacks may yield toppling of other stacks)	<u>SPILL-8-D</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use required by activity may impact stored containers from WASTE activity)
8C Stacked Waste Containers plus **7A Vehicles, Material Handling Equipment** or **13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash**	[indirect interaction] **Likelihood of failure** *Unlikely* (stacked wooden waste boxes can fail due to falling)	[indirect interaction] **Likelihood of failure** *Anticipated* (stacked wooden waste boxes can fail due to falling)	[direct interaction] **Likelihood of failure** *Anticipated* (stacked wooden waste boxes can fail due to falling)	[indirect interaction] **Likelihood of failure** *Unlikely* (stacked wooden waste boxes can fail due to falling)
<u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Potential MAR.** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	**Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence·** *Low* **Scenario Initial Risk Class·** *Risk Class III*	**Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class.** *Risk Class III*	**Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

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Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
Puncture Scenario 4 Failure of Wooden Container Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A Receipt and Shipment of Waste Containers at the Dock** or **11C Movement of Waste Containers in the Facility** plus **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	PUNCT-4-A **Likelihood of scenario** *Unlikely* [A1] (movement of in-process containers may occur during activity) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste box can puncture due to vehicle impact) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	PUNCT-4-B **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	PUNCT-4-C **Likelihood of scenario·** *Anticipated* (multiple movements of wooden waste containers) [direct interaction] **Likelihood of failure** *Anticipated* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence:** *Low* **Scenario Initial Risk Class** *Risk Class III*	PUNCT-4-D **Likelihood of scenario** *Unlikely* [A1] (movement of stored or staged containers may be required by activity) [direct interaction] **Likelihood of failure·** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
<u>Puncture Scenario 5</u> Failure of Wooden Container, Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-5-A</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not involve much container movement but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR:** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>PUNCT-5-B</u> **Likelihood of scenario** *Anticipated* (activity does not deal with wooden containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Anticipated* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR·** 3 grams (LLW box) **Scenario Consequence.** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>PUNCT-5-C</u> **Likelihood of scenario** *Anticipated* (placement of waste containers in stacks may yield impact with other stored containers) [direct interaction] **Likelihood of failure.** *Anticipated* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR.** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>PUNCT-5-D</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence.** *Low* **Scenario Initial Risk Class** *Risk Class III*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
	GEN	**SNM**	**WASTE**	**SURV**
Puncture Scenario 6 Failure of Wooden Container, Mechanical Failure, Puncture (or spill), By Structure, **13C Tunnel Degradation and Leakage** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**	PUNCT-6-A **Likelihood of scenario.** *Anticipated* [A2/A3] (high wind induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (wooden waste box can be punctured due to structural member impact)	PUNCT-6-B **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure** not applicable	PUNCT-6-C **Likelihood of scenario** *Anticipated* [A2/A3] (high wind induced structural failure dominates) [indirect interaction] **Likelihood of failure** *Anticipated* (wooden waste box can be punctured due to structural member impact)	PUNCT-6-D **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable
	Scenario Potential MAR contamination < 3 grams (LLW box)	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** area inventory of wooden LLW containers	**Scenario Potential MAR** not applicable
evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Consequence** *Low*	**Scenario Consequence·** not applicable	**Scenario Consequence:** *Moderate*	**Scenario Consequence·** not applicable
	Scenario Initial Risk Class *Risk Class III*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *Risk Class I*	**Scenario Initial Risk Class** *not applicable*

Table 62 Radioactive Material Handling Activity Hazard Evaluations

	BUILDING 991 COMPLEX RADIOACTIVE MATERIAL HANDLING ACTIVITIES			
SCENARIO	**GEN**	**SNM**	**WASTE**	**SURV**
<u>Facility Fire Scenario 4</u> Failure of Wooden Container, Thermal Failure, Facility Fire, **5B Propane** or **5C Natural Gas** or **5H Transport Vehicles** or **13F Combustibles** plus **5E Electric Power System** or **13G Seismic, Lightning, Aircraft Crash, Range Fire** <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>**FFIRE-4-A**</u> **Likelihood of scenario·** *Unlikely* [R8] (combustibles fire dominates) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste box can fail due to external fire) **Scenario Potential MAR** contamination < 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>**FFIRE-4-B**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden containers) [no interaction] **Likelihood of failure:** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>**FFIRE-4-C**</u> **Likelihood of scenario** *Unlikely* [R8] (combustibles fire dominates) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to external fire) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class I*	<u>**FFIRE-4-D**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Spill Scenario 1</u> Failure of Metal Container Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>SPILL-1-E</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to drop) *Beyond Extremely Unlikely* [F2] (POC container cannot be breached by short drops) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	<u>SPILL-1-F</u> **Likelihood of scenario:** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure·** *Unlikely* (metal waste drums / boxes can fail due to drop) *Beyond Extremely Unlikely* [F2] (POC container cannot be breached by short drops) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	<u>SPILL-1-G</u> **Likelihood of scenario.** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to drop) *Beyond Extremely Unlikely* [F2] (POC container cannot be breached by short drops) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	<u>SPILL-1-H</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
Spill Scenario 2 Failure of Metal Container, Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-2-E **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F3] (metal waste drums / boxes unlikely to fail from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F5] (POC container cannot be breached by vehicle impact) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	SPILL-2-F **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F3] (metal waste drums / boxes unlikely to fail from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F5] (POC container cannot be breached by vehicle impact) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	SPILL-2-G **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F3] (metal waste drums / boxes unlikely to fail from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F5] (POC container cannot be breached by vehicle impact) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	SPILL-2-H **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Spill Scenario 3</u> Failure of Metal Container, Mechanical Failure, Spill (structure impact),	<u>SPILL-3-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction]	<u>SPILL-3-F</u> **Likelihood of scenario·** *activity not related to scenario* (activity does not deal with storage) [no interaction]	<u>SPILL-3-G</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction]	<u>SPILL-3-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction]
13C Tunnel Degradation and Leakage or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**	**Likelihood of failure·** not applicable	**Likelihood of failure·** not applicable	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable
	Scenario Potential MAR not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable
<u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Consequence** not applicable	**Scenario Consequence·** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class·** *not applicable*	**Scenario Initial Risk Class·** *not applicable*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>Facility Explosion Scenario 1</u> Failure of Metal Container, Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **13I Seismic, Wind, Tornado, Lightning, Aircraft Crash**	<u>**FEXPLO-1-E**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable	<u>**FEXPLO-1-F**</u> **Likelihood of scenario:** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure:** *Extremely Unlikely* [R9] (metal waste drums / boxes can fail due to external explosions, hot work unlikely to impact waste containers) *Beyond Extremely Unlikely* [F9] (POC container cannot be breached by external flammable gas explosions)	<u>**FEXPLO-1-G**</u> **Likelihood of scenario:** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [R9] (metal waste drums / boxes can fail due to external explosions, hot work unlikely to impact waste containers) *Beyond Extremely Unlikely* [F9] (POC container cannot be breached by external flammable gas explosions)	<u>**FEXPLO-1-H**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable
<u>evaluated as a worst case container explosion</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable	**Scenario Potential MAR** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *Moderate* (LLW), *High* (TRU)	**Scenario Potential MAR** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *Moderate* (LLW), *High* (TRU)	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class II* (TRU)	**Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class II* (TRU)	**Scenario Initial Risk Class** *not applicable*

Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Spill Scenario 4 Failure of Metal Container, Mechanical Failure, Spill (stored container fall), **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	SPILL-4-E **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	SPILL-4-F **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence.** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	SPILL-4-G **Likelihood of scenario.** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure:** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)	SPILL-4-H **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked metal waste drums / boxes can fail due to falling) *Beyond Extremely Unlikely* [F2] (stacked POC container cannot be breached by falling) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 5,020 grams (POC pallet) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class III* (LLW), *Risk Class I* (TRU)

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	CHEM	CON	MAINT	RA
<u>**Puncture Scenario 1**</u> Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A/B Receipt and Shipment of Containers at the Dock or 11C Movement of Containers in the Facility** plus **7A Vehicles, Material Handling Equipment** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-1-E</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazards) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC container extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	<u>PUNCT-1-F</u> **Likelihood of scenario:** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC container extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	<u>PUNCT-1-G</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC container extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR·** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	<u>PUNCT-1-H</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Puncture Scenario 2 Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	PUNCT-2-E **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure.** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR·** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class.** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	PUNCT-2-F **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure:** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR:** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class:** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	PUNCT-2-G **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR:** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)	PUNCT-2-H **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [F10] (metal waste drums / boxes unlikely to puncture from vehicle impact except under special conditions) *Beyond Extremely Unlikely* [F12] (POC containers extremely unlikely to puncture from vehicle impact except under special conditions) **Scenario Potential MAR** 3 grams (LLW box), 400 grams (TRU pallet), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* (POC), *Low* (LLW), *High* (TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class IV* (LLW), *Risk Class II* (TRU)

Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Puncture Scenario 3</u> Failure of Metal Container, Mechanical Failure, Puncture (or spill), By Structure, **13C Tunnel Degradation and Leakage** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-3-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>PUNCT-3-F</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure·** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence·** not applicable **Scenario Initial Risk Class** *not applicable*	<u>PUNCT-3-G</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure·** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class·** *not applicable*	<u>PUNCT-3-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Facility Fire Scenario 1</u> Failure of Metal Container, Thermal Failure, Facility Fire, **5B Propane** <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>FFIRE-1-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>FFIRE-1-F</u> **Likelihood of scenario** *Extremely Unlikely* [R3] (activity may use flammable gases but difficult to directly impact stored container) [indirect interaction] **Likelihood of failure:** *Extremely Unlikely* (metal waste drums / boxes and POC containers can fail due to direct exposure to flammable gas flame) **Scenario Potential MAR** 3 grams (LLW box), 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class:** *Risk Class IV* (LLW), *Risk Class II* (TRU/POC)	<u>FFIRE-1-G</u> **Likelihood of scenario** *Extremely Unlikely* [R3] (activity may use flammable gases but difficult to directly impact stored container) [indirect interaction] **Likelihood of failure·** *Extremely Unlikely* (metal waste drums / boxes and POC containers can fail due to direct exposure to flammable gas flame) **Scenario Potential MAR** 3 grams (LLW box), 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *Low* (LLW), *High* (TRU/POC) **Scenario Initial Risk Class** *Risk Class IV* (LLW), *Risk Class II* (TRU/POC)	<u>FFIRE-1-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES CHEM	CON	MAINT	RA
Container Explosion Scenario 1 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Container Explosion (hydrogen), **6C Pressurized Metal Waste Containers** or **13A Hydrogen Generation in Metal Waste Containers** evaluated as a worst case container explosion [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	CEXPLO-1-E **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) **Scenario Potential MAR** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CEXPLO-1-F **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure.** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) **Scenario Potential MAR·** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class:** *not credible*	CEXPLO-1-G **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) **Scenario Potential MAR·** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CEXPLO-1-H **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with sealed metal waste containers but vehicle, material handling equipment use by activity may generate spark near stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F13] (metal waste containers are extremely unlikely to explode from hydrogen generation due to venting) **Scenario Potential MAR** 200 grams (TRU drum), 320 grams (TRU box), 1,255 grams (POC) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Criticality Scenario 1 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Intentional, **11A/B Receipt and Shipment of Containers at the Dock or 11C Movement of Containers in the Facility** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-1-E **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR** inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-1-F **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR·** inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-1-G **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [R5] (intact metal waste containers cannot be arranged to yield a criticality due to Criticality Safety Requirements) **Scenario Potential MAR** inventory of LLW, TRU waste, and POC containers **Scenario Consequence·** *none* **Scenario Initial Risk Class·** *not credible*	CRIT-1-H **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>Criticality Scenario 2</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Drop During Movement, **8B Raised Loads on Forklifts** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-2-E</u> **Likelihood of scenario·** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure:** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-2-F</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-2-G</u> **Likelihood of scenario·** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-2-H</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR:** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Criticality Scenario 3 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Equipment Impact, **7A Vehicles, Material Handling Equipment** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-3-E **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-3-F **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	CRIT-3-G **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	CRIT-3-H **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>Criticality Scenario 4</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Structure Impact, **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-4-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>CRIT-4-F</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>CRIT-4-G</u> **Likelihood of scenario.** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>CRIT-4-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
Criticality Scenario 5 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **13I Seismic, Wind, Tornado, Lightning, Aircraft Crash** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-5-E **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence·** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-5-F **Likelihood of scenario** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure** *Extremely Unlikely* [R9] (metal waste drums / boxes can fail due to external explosions, hot work unlikely to impact waste containers) *Beyond Extremely Unlikely* [A9/F9] (insufficient MAR in LLW to generate a criticality) (POC container cannot be breached by external flammable gas explosions) **Scenario Potential MAR** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence·** *none* (LLW/POC), *High* (TRU) **Scenario Initial Risk Class** *not credible* (LLW/POC), *Risk Class II* (TRU)	CRIT-5-G **Likelihood of scenario** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure·** *Extremely Unlikely* [R9] (metal waste drums / boxes can fail due to external explosions, hot work unlikely to impact waste containers) *Beyond Extremely Unlikely* [A9/F9] (insufficient MAR in LLW to generate a criticality) (POC container cannot be breached by external flammable gas explosions) **Scenario Potential MAR** room inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (LLW/POC), *High* (TRU) **Scenario Initial Risk Class** *not credible* (LLW/POC), *Risk Class II* (TRU)	CRIT-5-H **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Criticality Scenario 6</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Rearrangement, Unintentional, Stored Container Fall, **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13J Seismic, Heavy Rain, Heavy Snow, Flooding, Freezing, Aircraft Crash** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-6-E</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-6-F</u> **Likelihood of scenario·** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-6-G</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>CRIT-6-H</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A9] (insufficient MAR to generate a criticality) **Scenario Potential MAR·** 3 grams (LLW box), 800 grams (TRU pallet), 320 grams (TRU box), 800 grams (POC pallet) **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Criticality Scenario 7</u> Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Incorrect Moderation, **11A/B Receipt of Containers at the Dock** <u>evaluated as a minimal criticality</u> <u>[see A9]</u> [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	<u>CRIT-7-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>CRIT-7-F</u> **Likelihood of scenario** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure·** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class·** *not applicable*	<u>CRIT-7-G</u> **Likelihood of scenario·** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>CRIT-7-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not impact container moderation and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class.** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Criticality Scenario 8 Failure of Metal Container, Overpressure Failure, Internal, Rapid Rate, Criticality, Incorrect Loading, **11A/B Receipt of Containers at the Dock** evaluated as a minimal criticality [see A9] [Consequences *none* at or below 10 kilograms, *high* above 10 kilograms]	CRIT-8-E **Likelihood of scenario** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR·** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-8-F **Likelihood of scenario·** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-8-G **Likelihood of scenario** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence·** not applicable **Scenario Initial Risk Class** *not applicable*	CRIT-8-H **Likelihood of scenario** *activity not related to scenario* (activity does not impact container loading and does not deal with container receipt) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Material Fire Scenario 1 Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts**] evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**MFIRE-1-E** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**MFIRE-1-F** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	**MFIRE-1-G** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence.** *none* **Scenario Initial Risk Class** *not credible*	**MFIRE-1-H** **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Material Fire Scenario 2</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment]** <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**<u>MFIRE-2-E</u>** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F3/A10] (metal waste drums unlikely to fail from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**<u>MFIRE-2-F</u>** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F3/A10] (metal waste drums unlikely to fail from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	**<u>MFIRE-2-G</u>** **Likelihood of scenario·** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F3/A10] (metal waste drums unlikely to fail from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	**<u>MFIRE-2-H</u>** **Likelihood of scenario·** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
Material Fire Scenario 3 Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	**MFIRE-3-E** **Likelihood of scenario·** *activity not related to scenario* (activity does not deal with pyrophoric materials)	**MFIRE-3-F** **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	**MFIRE-3-G** **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	**MFIRE-3-H** **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)
Material Fire (pyrophoric),	[no interaction]	[no interaction]	[no interaction]	[no interaction]
5D Pyrophoric Materials plus [Mechanical Failure, Spill (structure impact),	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable
13C Tunnel Degradation and Leakage or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash]**	**Scenario Potential MAR** not applicable **Scenario Consequence·** not applicable	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable	**Scenario Potential MAR** not applicable **Scenario Consequence** not applicable
- evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class.** *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>Material Fire Scenario 4</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	<u>MFIRE-4-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with pyrophoric materials)	<u>MFIRE-4-F</u> **Likelihood of scenario·** *Anticipated* (multiple receipts of waste containers)	<u>MFIRE-4-G</u> **Likelihood of scenario** *Anticipated* (multiple receipts of waste containers)	<u>MFIRE-4-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with pyrophoric materials)
Material Fire (pyrophoric),	[no interaction]	[indirect interaction]	[indirect interaction]	[no interaction]
5D Pyrophoric Materials plus [Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus	**Likelihood of failure** not applicable	**Likelihood of failure** *Beyond Extremely Unlikely* [A10] (metal waste drums can fail due to external explosions exposing pyrophoric material) (pyrophoric materials are not introduced into the facility)	**Likelihood of failure** *Beyond Extremely Unlikely* [A10] (metal waste drums can fail due to external explosions exposing pyrophoric material) (pyrophoric materials are not introduced into the facility)	**Likelihood of failure** not applicable
5E Electric Power System or **13I Seismic, Wind, Tornado, Lightning, Aircraft Crash]**	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** none	**Scenario Potential MAR** none	**Scenario Potential MAR** not applicable
	Scenario Consequence not applicable	**Scenario Consequence** *none*	**Scenario Consequence** *none*	**Scenario Consequence** not applicable
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class·** *not credible*	**Scenario Initial Risk Class·** *not credible*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Material Fire Scenario 5</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Spill (stored container fall), **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash]** <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>MFIRE-5-E</u> **Likelihood of scenario** *Anticipated* (waste containers are stacked in the facility) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>MFIRE-5-F</u> **Likelihood of scenario** *Anticipated* (waste containers are stacked in the facility) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR.** none **Scenario Consequence:** *none* **Scenario Initial Risk Class** *not credible*	<u>MFIRE-5-G</u> **Likelihood of scenario.** *Anticipated* (waste containers are stacked in the facility) [indirect interaction] **Likelihood of failure·** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence·** *none* **Scenario Initial Risk Class·** *not credible*	<u>MFIRE-5-H</u> **Likelihood of scenario** *Anticipated* (waste containers are stacked in the facility) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [A10] (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
<u>Material Fire Scenario 6</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A/B Receipt and Shipment of Containers at the Dock** or **11C Movement of Containers in the Facility** plus **7A Vehicles, Material Handling Equipment**] <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>**MFIRE-6-E**</u> **Likelihood of scenario·** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR·** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>**MFIRE-6-F**</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>**MFIRE-6-G**</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>**MFIRE-6-H**</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Material Fire Scenario 7</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable Material Fire (pyrophoric), **5D Pyrophoric Materials** plus [Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment**] <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>MFIRE-7-E</u> **Likelihood of scenario** *Unlikely* [A6] (CHEM activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*	<u>MFIRE-7-F</u> **Likelihood of scenario·** *Unlikely* [A6] (CON activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR·** none **Scenario Consequence·** *none* **Scenario Initial Risk Class** *not credible*	<u>MFIRE-7-G</u> **Likelihood of scenario** *Unlikely* [A6] (MAINT activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class·** *not credible*	<u>MFIRE-7-H</u> **Likelihood of scenario** *Unlikely* [A6] (RA activities perform limited operations with material handling equipment) [indirect interaction] **Likelihood of failure** *Beyond Extremely Unlikely* [F10/A10] (metal waste drums unlikely to puncture from vehicle impact) (pyrophoric materials are not introduced into the facility) **Scenario Potential MAR** none **Scenario Consequence** *none* **Scenario Initial Risk Class** *not credible*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
<u>Material Fire Scenario 8</u> Failure of Metal Container, {Overpressure Failure, Internal, Moderate Rate,} - not applicable	<u>**MFIRE-8-E**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	<u>**MFIRE-8-F**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	<u>**MFIRE-8-G**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)	<u>**MFIRE-8-H**</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with pyrophoric materials)
Material Fire (pyrophoric),	[no interaction]	[no interaction]	[no interaction]	[no interaction]
5D Pyrophoric Materials plus [Mechanical Failure, Puncture (or spill), By Structure,	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable	**Likelihood of failure** not applicable
13C Tunnel Degradation and Leakage or	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable
13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash]	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable
<u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Facility Fire Scenario 2 Failure of Metal Container, Overpressure Failure, Facility Fire, Rapid Rate, Fuel Fire, **5H Transport Vehicles** or **13G Aircraft Crash**	**FFIRE-2-E** **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage or transport) [no interaction] **Likelihood of failure** not applicable	**FFIRE-2-F** **Likelihood of scenario·** *activity not related to scenario* (activity does not deal with storage or transport) [no interaction] **Likelihood of failure** not applicable	**FFIRE-2-G** **Likelihood of scenario:** *activity not related to scenario* (activity does not deal with storage or transport) [no interaction] **Likelihood of failure** not applicable	**FFIRE-2-H** **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage or transport) [no interaction] **Likelihood of failure** not applicable
	Scenario Potential MAR not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable
evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Facility Fire Scenario 3 Failure of Metal Container, Overpressure Failure, Facility Fire, Moderate Rate, Combustible Material Fire, **5B Propane** or **5C Natural Gas** or **13F Combustibles** plus **5E Electric Power System** or **13G Seismic, Lightning, Range Fire** evaluated as a worst case fire [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	**FFIRE-3-E** **Likelihood of scenario** *Unlikely* [R8] (activity may involve combustibles, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to external fire) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR** area inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *High* (LLW/TRU) **Scenario Initial Risk Class·** *not credible* (POC), *Risk Class I* (LLW/TRU)	**FFIRE-3-F** **Likelihood of scenario·** *Unlikely* [F17/R8] (activity may use flammable gases and involve combustibles, gas containers unlikely to be breached during use, combustibles are controlled) [indirect interaction] **Likelihood of failure·** *Unlikely* (metal waste drums / boxes can fail due to external fire) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR** area inventory of LLW, TRU waste, and POC containers **Scenario Consequence·** *none* (POC), *High* (LLW/TRU) **Scenario Initial Risk Class·** *not credible* (POC), *Risk Class I* (LLW/TRU)	**FFIRE-3-G** **Likelihood of scenario·** *Unlikely* [F17/R8] (activity may use flammable gases and involve combustibles, gas containers unlikely to be breached during use, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to external fire) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR.** area inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *High* (LLW/TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class I* (LLW/TRU)	**FFIRE-3-H** **Likelihood of scenario** *Unlikely* [R8] (activity may involve combustibles, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (metal waste drums / boxes can fail due to external fire) *Beyond Extremely Unlikely* [F16] (POC container cannot be breached by external fires) **Scenario Potential MAR** area inventory of LLW, TRU waste, and POC containers **Scenario Consequence** *none* (POC), *High* (LLW/TRU) **Scenario Initial Risk Class** *not credible* (POC), *Risk Class I* (LLW/TRU)

Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>Spill Scenario 5</u> Failure of Wooden Container Mechanical Failure, Spill (during movement), **8B Raised Loads on Forklifts** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>SPILL-5-E</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to drop) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-5-F</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to drop) **Scenario Potential MAR:** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-5-G</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to drop) **Scenario Potential MAR·** 3 grams (LLW box) **Scenario Consequence·** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-5-H</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class·** *not applicable*

Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
Spill Scenario 6 Failure of Wooden Container Mechanical Failure, Spill (equipment impact), **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**SPILL-6-E** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	**SPILL-6-F** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	**SPILL-6-G** **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	**SPILL-6-H** **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Spill Scenario 7</u> Failure of Wooden Container Mechanical Failure, Spill (structure impact), **13C Tunnel Degradation and Leakage** or **13E Floor Loading** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash**	<u>SPILL-7-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable	<u>SPILL-7-F</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable	<u>SPILL-7-G</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable	<u>SPILL-7-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable
	Scenario Potential MAR not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable	**Scenario Potential MAR** not applicable
<u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable	**Scenario Consequence** not applicable
	Scenario Initial Risk Class *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*	**Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
Facility Explosion Scenario 2 Failure of Wooden Container Mechanical Failure, Facility Explosion, **5B Propane** or **5C Natural Gas** plus **5E Electric Power System** or **131 Seismic, Wind, Tornado, Lightning, Aircraft Crash** evaluated as a worst case container explosion [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	FEXPLO-2-E **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class:** *not applicable*	FEXPLO-2-F **Likelihood of scenario** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure·** *Extremely Unlikely* [R9] (wooden waste box can fail due to external explosions, hot work unlikely to impact waste containers) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence·** *Moderate* **Scenario Initial Risk Class.** *Risk Class III*	FEXPLO-2-G **Likelihood of scenario** *Unlikely* [F17] (activity may use flammable gases, gas containers unlikely to be breached during use) [indirect interaction] **Likelihood of failure.** *Extremely Unlikely* [R9] (wooden waste box can fail due to external explosions, hot work unlikely to impact waste containers) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *Moderate* **Scenario Initial Risk Class·** *Risk Class III*	FEXPLO-2-H **Likelihood of scenario** *activity not related to scenario* (activity does not use flammable gases and does not deal with wooden container storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Spill Scenario 8</u> Failure of Wooden Container, Mechanical Failure, Spill (stored container fall), **8C Stacked Waste Containers** plus **7A Vehicles, Material Handling Equipment** or **13H Seismic, Heavy Rain, Flooding, Freezing, Aircraft Crash** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>SPILL-8-E</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked wooden waste boxes can fail due to falling) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class·** *Risk Class III*	<u>SPILL-8-F</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked wooden waste boxes can fail due to falling) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-8-G</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure·** *Unlikely* (stacked wooden waste boxes can fail due to falling) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>SPILL-8-H</u> **Likelihood of scenario** *Unlikely* [A6] (activity does not stack containers but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (stacked wooden waste boxes can fail due to falling) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
SCENARIO	**CHEM**	**CON**	**MAINT**	**RA**
<u>Puncture Scenario 4</u> Failure of Wooden Container Mechanical Failure, Puncture (or spill), By Forklift, Intentional Move, **11A Receipt and Shipment of Waste Containers at the Dock** or **11C Movement of Waste Containers in the Facility** plus **7A Vehicles, Material Handling Equipment** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-4-E</u> **Likelihood of scenario·** *Unlikely* [A1] (movement of stored containers may be required to remove chemical hazard) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>PUNCT-4-F</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform construction work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*	<u>PUNCT-4-G</u> **Likelihood of scenario** *Unlikely* [A1] (movement of stored containers may be required to perform maintenance work) [direct interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class.** *Risk Class III*	<u>PUNCT-4-H</u> **Likelihood of scenario** *activity not related to scenario* (activity is not expected to require movement of stored containers) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
Puncture Scenario 5 Failure of Wooden Container, Mechanical Failure, Puncture (or spill), By Forklift, Unintentional Impact, Equipment Impact, **7A Vehicles, Material Handling Equipment** evaluated as a worst case spill [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	PUNCT-5-E **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence·** *Low* **Scenario Initial Risk Class** *Risk Class III*	PUNCT-5-F **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence:** *Low* **Scenario Initial Risk Class** *Risk Class III*	PUNCT-5-G **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR·** 3 grams (LLW box) **Scenario Consequence·** *Low* **Scenario Initial Risk Class·** *Risk Class III*	PUNCT-5-H **Likelihood of scenario** *Unlikely* [A6] (activity does not deal with storage but vehicle, material handling equipment use by activity may impact stored containers from WASTE activity) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can puncture due to vehicle impact) **Scenario Potential MAR** 3 grams (LLW box) **Scenario Consequence** *Low* **Scenario Initial Risk Class** *Risk Class III*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	**CON**	**MAINT**	**RA**
<u>**Puncture Scenario 6**</u> Failure of Wooden Container, Mechanical Failure, Puncture (or spill), By Structure, **13C Tunnel Degradation and Leakage** or **13H Seismic, Wind, Tornado, Heavy Snow, Aircraft Crash** <u>evaluated as a worst case spill</u> [Consequences *low* at or below 3 18 grams, *high* above 157 grams]	<u>PUNCT-6-E</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>PUNCT-6-F</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>PUNCT-6-G</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*	<u>PUNCT-6-H</u> **Likelihood of scenario** *activity not related to scenario* (activity does not deal with storage) [no interaction] **Likelihood of failure** not applicable **Scenario Potential MAR** not applicable **Scenario Consequence** not applicable **Scenario Initial Risk Class** *not applicable*

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Table 63 Other (Non-SNM) Activity Hazard Evaluations

SCENARIO	BUILDING 991 COMPLEX OTHER (NON-SNM) ACTIVITIES			
	CHEM	CON	MAINT	RA
<u>Facility Fire Scenario 4</u> Failure of Wooden Container, Thermal Failure, Facility Fire, **5B Propane** or **5C Natural Gas** or **5H Transport Vehicles** or **13F Combustibles** plus **5E Electric Power System** or **13G Seismic, Lightning, Aircraft Crash, Range Fire** <u>evaluated as a worst case fire</u> [Consequences *low* at or below 0 063 grams, *high* above 3 1 grams]	<u>**FFIRE-4-E**</u> **Likelihood of scenario** *Unlikely* [R8] (activity may involve combustibles, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to external fire) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class I*	<u>**FFIRE-4-F**</u> **Likelihood of scenario** *Unlikely* [F17/R8] (activity may use flammable gases and involve combustibles, gas containers unlikely to be breached during use, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to external fire) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class I*	<u>**FFIRE-4-G**</u> **Likelihood of scenario** *Unlikely* [F17/R8] (activity may use flammable gases and involve combustibles, gas containers unlikely to be breached during use, combustibles are controlled) [indirect interaction] **Likelihood of failure.** *Unlikely* (wooden waste boxes can fail due to external fire) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class I*	<u>**FFIRE-4-H**</u> **Likelihood of scenario** *Unlikely* [R8] (activity may involve combustibles, combustibles are controlled) [indirect interaction] **Likelihood of failure** *Unlikely* (wooden waste boxes can fail due to external fire) **Scenario Potential MAR** area inventory of wooden LLW containers **Scenario Consequence** *High* **Scenario Initial Risk Class** *Risk Class I*

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Table 62 and Table 63 presented the hazard evaluation matrices for the Building 991 Complex Five types of containers containing radioactive material were evaluated (1) Type B shipping containers, (2) POCs, (3) metal TRU waste containers, (4) metal LLW containers, and (5) wooden LLW containers These container types were assessed against 296 release scenario and activity combinations yielding a potential 1,480 combinations of container types, scenarios, and activities However, not all container types were applicable to all the scenario and activity combinations

Each combination of container type, initial release scenario, and activity was evaluated for applicability of the activity to the container / scenario combination, credibility of applicable activity / container / scenario combinations, and risk class of credible combinations At this point, combinations that are not applicable can be removed from further consideration Combinations that are not credible can be removed from further consideration as long as any assumptions, protective features, and/or requirements associated with making the combination not credible are carried forward The remaining combinations have risk class determinations that can be used for determining candidate accident scenarios for the accident analysis step of the Safety Analysis

To support the development of candidate accident scenarios, a summary table of the hazard evaluation results is developed and displayed in Table 64 The table lists each of the 37 release scenarios along with a brief description of the scenario The scenario description includes a designation of whether the scenario is an internal event (IE), an external event (EE), or both and provides the numerical codes for the scenario set of hazards / energy sources from Table 8 For each scenario, Table 64 presents a listing of the five container types (shown under the "Type" column of the table) and the eight general activities associated with the Building 991 Complex A matrix of hazard evaluation results is presented for the 1,480 activity / container / scenario combinations indicating if the combination is not applicable (NA), not credible (NC), or not specifically addressed in the hazard evaluation tables ("blank") and therefore not applicable For combinations that are applicable, credible, and addressed, the table displays the scenario initial risk class (I, II, III, or IV) along with the corresponding frequency bin (A - anticipated, U - unlikely, or E - extremely unlikely) / consequence bin (L - low, M - moderate, or H - high) combination yielding the risk class result Risk Class I and II scenarios are shown as shaded in the table to highlight the initial release scenarios that must be carried forward for further analysis

Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
MFIRE-1	Pyrophoric material fire due to container breach following drop from forklift leading to spill	LLW w	NA							NA
		LLW m	NA							NA
		TRU	NA		NC	NC	NC	NC	NC	NA
		POC	NA							NA
	IE [5D + 8B]	Type B	NA	NC		NC				NA
MFIRE-2	Pyrophoric material fire due to container breach following equipment impact leading to spill	LLW w	NA							NA
		LLW m	NA							NA
		TRU	NA		NC	NC	NC	NC	NC	NA
		POC	NA							NA
	IE [5D + 7A]	Type B	NA	NC		NC				NA
MFIRE-3	Pyrophoric material fire due to container breach following facility failure and structural member impacts leading to spill	LLW w	NA			NA	NA	NA	NA	NA
		LLW m	NA			NA	NA	NA	NA	NA
		TRU	NA		NC	NA	NA	NA	NA	NA
		POC	NA			NA	NA	NA	NA	NA
	IE [5D + 13C/13E] / EE [5D + 13H]	Type B	NA	NC		NA	NA	NA	NA	NA
MFIRE-4	Pyrophoric material fire due to container breach following flammable gas explosion leading to spill	LLW w	NA			NA	NA			NA
		LLW m	NA			NA	NA			NA
		TRU	NA		NC	NA	NA	NC	NC	NA
	IE [5D + 5B/5C + 5E] /	POC	NA			NA	NA			NA
	EE [5D + 5B/5C + 13I]	Type B	NA	NC		NA	NA			NA
MFIRE-5	Pyrophoric material fire due to container breach following equipment or material impact against stack leading to spill	LLW w								
		LLW m								
		TRU	NC	NC	NC	NC	NC	NC	NC	NC
		POC								
	IE [5D + 8C + 7A] / EE [5D + 8C + 13H]	Type B		NC		NC				
MFIRE-6	Pyrophoric material fire due to container breach following equipment impact and puncture (intentional movement)	LLW w	NA							NA
		LLW m	NA							NA
		TRU	NA		NC	NC	NC	NC	NC	NA
		POC	NA							NA
	IE [5D + 11A/11B/11C + 7A]	Type B	NA	NC		NC				NA

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Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
MFIRE-7	Pyrophoric material fire due to container breach following equipment impact and puncture (unintentional impact)	LLW w								
		LLW m								
		TRU	NC	NC	NC	NC	NC	NC	NC	NC
		POC								
	IE [5D + 7A]	Type B								
MFIRE-8	Pyrophoric material fire due to container breach following facility failure and structural member impacts leading to puncture	LLW w	NA			NA	NA	NA	NA	NA
		LLW m	NA			NA	NA	NA	NA	NA
		TRU	NA		NC	NA	NA	NA	NA	NA
		POC	NA			NA	NA	NA	NA	NA
	IE [5D + 13C] / EE [5D + 13H]	Type B	NA	NC		NA	NA	NA	NA	NA
FFIRE-1	Facility fire involving flammable gas device with direct flame impingement on container	LLW w				NA	NA			NA
		LLW m	NC		IV-E/L	NA	NA	IV-E/L	IV-E/L	NA
		TRU			II-E/H	NA	NA	II-E/H	II-E/H	NA
		POC			II-E/H	NA	NA	II-E/H	II-E/H	NA
	IE [5B]	Type B		NC		NA	NA			NA
FFIRE-2	Facility fire involving either transport vehicle fire or aircraft crash fire	LLW w				NA	NA	NA	NA	NA
		LLW m	NC		II-E/H	NA	NA	NA	NA	NA
		TRU			II-E/H	NA	NA	NA	NA	NA
		POC			NC	NA	NA	NA	NA	NA
	IE [5H] / EE [13G]	Type B		NC		NA	NA	NA	NA	NA
FFIRE-3	Facility fire involving flammable gases or combustibles	LLW w				NA				
		LLW m	III-U/L		I-U/H	NA	I-U/H	I-U/H	I-U/H	I-U/H
		TRU			[illegible]	NA	I-U/H	I-U/H	I-U/H	I-U/H
	IE [5B/5C/13F + 5E] /	POC			NC	NA	NC	NC	NC	NC
	EE [5B/5C/13F + 13G]	Type B		NC		NA				
FFIRE-4	Facility fire involving flammable gases, combustibles, or transport vehicles	LLW w	III-U/L	NA	I-U/H	NA	I-U/H	I-U/H	I-U/H	I-U/H
		LLW m		NA		NA				
		TRU		NA		NA				
	IE [5B/5C/5H/13F + 5E] /	POC		NA		NA				
	EE [5B/5C/5H/13F + 13G]	Type B		NA		NA				

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Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
SPILL-1	Container breach following drop from forklift leading to spill	LLW w								NA
		LLW m	III-U/L		III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	NA
		TRU			I-A/H	I-U/H	I-U/H	I-U/H	I-U/H	NA
		POC			NC	NC	NC	NC	NC	NA
	IE [8B]	Type B		NC		NC				NA
SPILL-2	Container breach following equipment impact leading to spill	LLW w								NA
		LLW m	IV-E/L		III-U/L	IV-E/L	IV-E/L	IV-E/L	IV-E/L	NA
		TRU			I-U/H	II-E/H	II-E/H	II-E/H	II-E/H	NA
		POC			NC	NC	NC	NC	NC	NA
	IE [7A]	Type B		NC		NC				NA
SPILL-3	Container breach following facility failure and structural member impacts leading to spill	LLW w				NA	NA	NA	NA	NA
		LLW m	III-A/L		I-A/M	NA	NA	NA	NA	NA
		TRU			I-A/H	NA	NA	NA	NA	NA
		POC			I-U/H	NA	NA	NA	NA	NA
	IE [13C/13E] / EE [13H]	Type B		II-E/H		NA	NA	NA	NA	NA
SPILL-4	Container breach following equipment impact against stack leading to spill	LLW w								
		LLW m	III-U/L	III-A/L	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	III-U/L
		TRU	I-U/H	I-A/H	I-A/H	I-U/H	I-U/H	I-U/H	I-U/H	I-U/H
		POC	NC	NC	NC	NC	NC	NC	NC	NC
	IE [8C + 7A] / EE [8C + 13H]	Type B								
SPILL-5	Wooden container breach following drop from forklift leading to spill	LLW w	III-U/L	NA	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	NA
		LLW m		NA						NA
		TRU		NA						NA
		POC		NA						NA
	IE [8B]	Type B		NA						NA
SPILL-6	Wooden container breach following equipment impact leading to spill	LLW w	III-U/L	NA	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	NA
		LLW m		NA						NA
		TRU		NA						NA
		POC		NA						NA
	IE [7A]	Type B		NA						NA

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Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
SPILL-7	Wooden container breach following facility failure and structural member impacts leading to spill	LLW w	III-A/L	NA	II-A/M	NA	NA	NA	NA	NA
		LLW m		NA		NA	NA	NA	NA	NA
		TRU		NA		NA	NA	NA	NA	NA
		POC		NA		NA	NA	NA	NA	NA
	IE [13C/13E] / EE [13H]	Type B		NA		NA	NA	NA	NA	NA
SPILL-8	Wooden container breach following equipment or material impact against stack leading to spill	LLW w	III-U/L	III-A/L	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	III-U/L
		LLW m								
		TRU								
		POC								
	IE [8C + 7A] / EE [8C + 13H]	Type B								
PUNCT-1	Container breach following equipment impact and puncture (intentional movement)	LLW w								NA
		LLW m	IV-E/L		III-U/L	IV-E/L	IV-E/L	IV-E/L	IV-E/L	NA
		TRU			II-U/H	II-E/H	II-E/H	II-E/H	II-E/H	NA
		POC			II-E/H	NC	NC	NC	NC	NA
	IE [11A/11B/11C + 7A]	Type B		II-E/H		NC				NA
PUNCT-2	Container breach following equipment impact and puncture (unintentional impact)	LLW w								
		LLW m	IV-E/L	III-U/L	III-U/L	IV-E/L	IV-E/L	IV-E/L	IV-E/L	IV-E/L
		TRU	II-E/H	II-U/H	II-U/H	II-E/H	II-E/H	II-E/H	II-E/H	II-E/H
		POC	NC	II-E/H	II-E/H	NC	NC	NC	NC	NC
	IE [7A]	Type B								
PUNCT-3	Container breach following facility failure and structural member impacts leading to puncture	LLW w				NA	NA	NA	NA	NA
		LLW m	III-A/L		II-A/M	NA	NA	NA	NA	NA
		TRU			II-A/H	NA	NA	NA	NA	NA
		POC			II-U/H	NA	NA	NA	NA	NA
	IE [13C] / EE [13H]	Type B		II-E/H		NA	NA	NA	NA	NA
PUNCT-4	Wooden container breach following equipment impact and puncture (intentional movement)	LLW w	III-U/L	NA	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	NA
		LLW m		NA						NA
		TRU		NA						NA
		POC		NA						NA
	IE [11A/11C + 7A]	Type B		NA						NA

Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
PUNCT-5	Wooden container breach following equipment impact and puncture (unintentional impact)	LLW w	III-U/L	III-A/L	III-A/L	III-U/L	III-U/L	III-U/L	III-U/L	III-U/L
		LLW m								
		TRU								
		POC								
	IE [7A]	Type B								
PUNCT-6	Wooden container breach following facility failure and structural member impacts leading to puncture	LLW w	III-A/L	NA	II-A/M	NA	NA	NA	NA	NA
		LLW m		NA		NA	NA	NA	NA	NA
		TRU		NA		NA	NA	NA	NA	NA
		POC		NA		NA	NA	NA	NA	NA
	IE [13C] / EE [13H]	Type B		NA		NA	NA	NA	NA	NA
CEXPLO-1	Container breach following accumulation of hydrogen and internal explosion	LLW w								
		LLW m								
		TRU	NC	NC	II-E/H	II-E/H	NC	NC	NC	NC
		POC	NC	NC	NC	NC	NC	NC	NC	NC
	IE [6C/13A]	Type B								
FEXPLO-1	Container breach following flammable gas explosion	LLW w				NA	NA			NA
		LLW m	IV-E/L		III-E/M	NA	NA	III-E/M	III-E/M	NA
		TRU			II-E/H	NA	NA	II-E/H	II-E/H	NA
		POC			NC	NA	NA	NC	NC	NA
	IE [5B/5C + 5E] / EE [5B/5C + 13I]	Type B		NC		NA	NA			NA
FEXPLO-2	Wooden container breach following flammable gas explosion	LLW w	IV-E/L	NA	III-E/M	NA	NA	III-E/M	III-E/M	NA
		LLW m		NA		NA	NA			NA
		TRU		NA		NA	NA			NA
		POC		NA		NA	NA			NA
	IE [5B/5C + 5E] / EE [5B/5C + 13I]	Type B		NA		NA	NA			NA

Table 64 Summary of Hazard Evaluation Results

SCENARIO	DESCRIPTION	TYPE	ACTIVITY[1] GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
CRIT-1	Criticality due to intentional rearrangement of containers	LLW w								NA
		LLW m	NC		NC	NC	NC	NC	NC	NA
		TRU			NC	NC	NC	NC	NC	NA
		POC			NC	NC	NC	NC	NC	NA
	IE [11A/11B/11C]	Type B		NC		NC				NA
CRIT-2	Criticality due to container breach following drop from forklift leading to spill	LLW w								NA
		LLW m	NC		NC	NC	NC	NC	NC	NA
		TRU			NC	NC	NC	NC	NC	NA
		POC			NC	NC	NC	NC	NC	NA
	IE [8B]	Type B		NC		NC				NA
CRIT-3	Criticality due to container breach following equipment impact leading to spill	LLW w								NA
		LLW m	NC		NC	NC	NC	NC	NC	NA
		TRU			NC	NC	NC	NC	NC	NA
		POC			NC	NC	NC	NC	NC	NA
	IE [7A]	Type B		NC		NC				NA
CRIT-4	Criticality due to container breach following facility failure and structural member impacts leading to spill	LLW w				NA	NA	NA	NA	NA
		LLW m	NC		NC	NA	NA	NA	NA	NA
		TRU			I-A/H	NA	NA	NA	NA	NA
		POC			I-U/H	NA	NA	NA	NA	NA
	IE [13C/13E] / EE [13H]	Type B		II-E/H		NA	NA	NA	NA	NA
CRIT-5	Criticality due to container breach following flammable gas explosion leading to spill	LLW w				NA	NA			NA
		LLW m	NC		NC	NA	NA	NC	NC	NA
		TRU			II-E/H	NA	NA	II-E/H	II-E/H	NA
		POC			NC	NA	NA	NC	NC	NA
	IE [5B/5C + 5E] / EE [5B/5C + 13I]	Type B		NC		NA	NA			NA
CRIT-6	Criticality due to container breach following equipment or material impact against stack leading to spill	LLW w								
		LLW m	NC	NC	NC	NC	NC	NC	NC	NC
		TRU	NC	NC	NC	NC	NC	NC	NC	NC
		POC	NC	NC	NC	NC	NC	NC	NC	NC
	IE [8C + 7A] / EE [8C + 13J]	Type B								

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Table 64 Summary of Hazard Evaluation Results

			ACTIVITY[1]							
SCENARIO	DESCRIPTION	TYPE	GEN	SNM	WASTE	SURV	CHEM	CON	MAINT	RA
CRIT-7	Criticality due to incorrect moderation of container contents or arrangement	LLW w	NA			NA	NA	NA	NA	NA
		LLW m	NA		NC	NA	NA	NA	NA	NA
		TRU	NA		NC	NA	NA	NA	NA	NA
		POC	NA		NC	NA	NA	NA	NA	NA
	IE [11A/11B]	Type B	NA	NC		NA	NA	NA	NA	NA
CRIT-8	Criticality due to incorrectly loading of container contents	LLW w	NA			NA	NA	NA	NA	NA
		LLW m	NA		NC	NA	NA	NA	NA	NA
		TRU	NA		NC	NA	NA	NA	NA	NA
		POC	NA		NC	NA	NA	NA	NA	NA
	IE [11A/11B]	Type B	NA	NC		NA	NA	NA	NA	NA

[1]NA - not applicable, NC - not credible, risk classes for scenario (I, II, III, IV), frequency bins (A - anticipated, U - unlikely, E - extremely unlikely), consequence bins (L - low, M - moderate, H - high), "blank" - not covered or addressed

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As stated above, Table 64 presents all 1,480 combinations of container types, release scenarios, and activities Examination of Table 64 indicates the following

- 1,111 combinations are not applicable (*i e*, marked "NA" or left blank),
- 205 combinations are not credible (47 material fires, 11 facility fires, 22 spills, 11 punctures, 14 container explosions, 4 facility explosions, and 96 criticalities),
- 21 combinations are Risk Class IV (0 material fires, 3 facility fires, 5 spills, 11 punctures, 0 container explosions, 2 facility explosions, and 0 criticalities),
- 64 combinations are Risk Class III (0 material fires, 2 facility fires, 37 spills, 19 punctures, 0 container explosions, 6 facility explosions, and 0 criticalities),
- 37 combinations are Risk Class II (0 material fires, 8 facility fires, 5 spills, 15 punctures, 2 container explosions, 3 facility explosions, and 4 criticalities), and
- 42 combinations are Risk Class I (0 material fires, 15 facility fires, 18 spills, 7 punctures, 0 container explosions, 0 facility explosions, and 2 criticalities)

Of the original 1,480 combinations in the hazard evaluation, 290 combinations potentially have assumptions, protective features, or requirements that are necessary to maintain a low risk class designation or to remain not credible scenarios The 79 combinations yielding Risk Class I or Risk Class II scenarios provide the impetus for further analysis The discussions that follow lead to the determination of the bounding set of accident scenarios to be carried forward to the accident analysis portion of the Safety Analysis

Prior to entering the bounding accident scenario selection process, the set of scenarios to be considered in the evaluation must be defined Obviously, the 1,111 scenario combinations that were determined to be not applicable can be removed from consideration The 205 scenario combinations that were determined to be not credible (*i e*, *Beyond Extremely Unlikely*) are candidates for removal from consideration as long as the set of assumptions, protective features, and requirements identified in the hazard evaluation table that lead to the low scenario frequency determination are carried forward into the final control set specified in the Building 991 Complex TSRs This approach will be taken to remove the *not credible* scenarios from further analysis and the corresponding controls are identified below The Risk Class I, II, III, and IV scenarios will enter the bounding scenario selection process

The assumptions, protective features, and requirements supporting the determination that a hazard evaluation scenario combination is not credible are identified and defined in Table 61 through Table 63 Table 65 lists the 205 scenario combinations (*i e*, scenario label and container type) that were determined to be not credible along with the controls that support and maintain that determination These identified controls must be included in the TSR control set for the Building 991 Complex

Table 65 Credited Protective Features and Requirements Yielding Not Credible Scenarios

SCENARIO CODE	TYPE	ASSUMPTION / FEATURE / REQUIREMENT	CONTROL / REMARKS
MFIRE-1-B/D, MFIRE-2-B/D, MFIRE-4-B, FFIRE-2-B, FFIRE-3-B, SPILL-1-B/D, SPILL-2-B/D, FEXPLO-1-B, CRIT-2-B/D, CRIT-3-B/D, CRIT-5-B	Type B	F1 - cannot be breached by potential falls, F4 - cannot be breached by potential vehicle impacts, F8 - cannot be breached by potential external flammable gas explosions, F15 - cannot be breached by potential external fires other than torches	Type B Shipping Container Design
MFIRE-6-D, PUNCT-1-D	Type B	A1/F11 - *unlikely* to be moved and *extremely unlikely* to be punctured by vehicle impacts	Type B Shipping Container Design
MFIRE-5-B/D	Type B	R1 - Type B containers only staged in single planar array	Administrative Control
FFIRE-1-B	Type B	R2 - flammable gas use in vaults prohibited while SNM is present	Administrative Control
CRIT-1-B/D, CRIT-2-B/D, CRIT-3-B/D, CRIT-7-B, CRIT-8-B	Type B	R4 - cannot be arranged to yield criticality if intact	Criticality Safety Requirements
MFIRE-3-B, MFIRE-6-B/D, MFIRE-8-B	Type B	A2/A3/F6/R10 – Type B containers *unlikely* to be breached by structural impact and containers compliant with 1-W89-HSP-31 11 F11/R10 – Type B containers *extremely unlikely* to be breached by forklift tine impacts and containers compliant with 1-W89-HSP-31 11	Administrative Control
FFIRE-2-C, FFIRE-3-C/E/F/G/H, SPILL-1-C/D/E/F/G, SPILL-2-C/D/E/F/G, SPILL-4-A/B/C/D/E/F/G/H, CEXPLO-1-C/D, FEXPLO-1-C/F/G, CRIT-5-C/F/G	POC	F2 - cannot be breached by potential falls, F5 - cannot be breached by potential vehicle impacts, F9 - cannot be breached by potential external flammable gas explosions, F14 - cannot be breached by internal hydrogen explosion, F16 - cannot be breached by potential external fires other than torches	POC Design

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Table 65 Credited Protective Features and Requirements Yielding Not Credible Scenarios

SCENARIO CODE	TYPE	ASSUMPTION / FEATURE / REQUIREMENT	CONTROL / REMARKS
PUNCT-1-D/E/F/G, PUNCT-2-A/D/E/F/G/H	POC	A1/F12 - *unlikely* to be moved and *extremely unlikely* to be punctured by vehicle impacts, A6/F12 - *unlikely* to be impacted and *extremely unlikely* to be punctured by vehicle impacts	POC Design
CEXPLO-1-A/B/E/F/G/H	metal container	A6/F13 - *unlikely* to be impacted and *extremely unlikely* to have internal hydrogen explosion, A8/F13 - *unlikely* to be impacted and *extremely unlikely* to have internal hydrogen explosion	Vented Metal Container
CRIT-1-C/D/E/F/G, CRIT-7-C, CRIT-8-C	metal container	R5 - cannot be arranged to yield criticality if intact	Criticality Safety Requirements
MFIRE-1-C/D/E/F/G MFIRE-2-C/D/E/F/G MFIRE-3-C MFIRE-4-C/F/G MFIRE-5-A/C/D/E/F/G/H MFIRE-6-C/D/E/F/G MFIRE-7-A/B/C/D/E/F/G/H MFIRE-8-C	metal container	A10 – no pyrophoric material containers will be brought into the facility	Administrative Control
FFIRE-2-A	metal container	A12/A13/A14 - *unlikely* transport vehicle fires, *unlikely* exposure to in-process containers, and *unlikely* fire propagation	Vehicle Inspection
FFIRE-1-A	metal container	A7 - time associated with generation of waste under the GEN activity is very limited	No control, basic assumption
CRIT-1-A, CRIT-2-A/C/D/E/F/G, CRIT-3-A/C/D/E/F/G, CRIT-4-A/C, CRIT-5-A/C/F/G, CRIT-6-A/B/C/D/E/F/G/H	metal container	A9 - 10 kilograms of oxide needed for criticality	No control, basic assumption

4.3.2 Planned Design and Operational Safety Improvements

Building 991 is installing a fire door between the Office Area (Room 101 through Room 129, south portion of the building) and the radioactive material storage areas (closest area is Room 134) in the north-south corridor of the facility This design improvement serves to reduce the threat of Office Area fires propagating into the waste storage areas of the facility

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Building 991 is upgrading the fire door between Room 170 and Room 141 and the fire door between Room 170 and Room 134 This design improvement further establishes the fire barrier between the north and south fire zones, as defined in the Fire Hazards Analysis (FHA), of the facility (Ref 33)

Significant quantities of materials, including combustibles, are being removed from Building 991 in preparation for waste storage The areas currently being cleared include Room 143, Room 155, and Room 166 This operational safety improvement reduces the facility combustible loading and reduces the threat of large fires

The Building 991 Complex steam heating system is being replaced by a hot water system supported by natural gas fueled boilers located east of Room 166 The complex will no longer utilize Site steam This design improvement eliminates the high pressure hazard and reduces the high temperature hazard associated with the steam lines versus hot water lines but does introduce a thermal, flammable gas hazard associated with the natural gas fueled boilers

Corridor C, Building 997, and Building 999 are not going to be used for any storage due to the uncertainty associated with structural integrity of the Corridor C tunnel This operational safety improvement addresses a life safety concern associated with the area

4.3.3 Protective Features and Layers of Defense

Table 56 and Table 65 have identified protective features for the maintenance of Standard Industrial Hazards and for the maintenance of the determination that specific scenario combinations are not credible (*i e , Beyond Extremely Unlikely*) Some of these protective features can also be credited in the evaluation of the bounding accident scenarios Figure 3, Figure 4, and Figure 5 display the layers of defense provided by the credited protective features identified in the hazard evaluation process for protection against chemical, energy source, and radiological hazards, respectively

The layers of defense figures are constructed showing the hazard of interest at the far left of the figure Each shell of the layers of defense is shown as a box surrounding (except for the left side) the hazard of interest and any previous shells Layers of defense are shown from the left to the right, with the innermost layer being at the left and the outermost layer being at the far right In addition, the figures distinguish between hardware protective features (shown in upper half of the figure) and administrative protective features (shown in the lower half of the figure) Protective features are shown in bold type and SMPs that implement and/or control the protective features are identified, where applicable

The layering of protective features makes distinctions between innermost, middle, and outermost Innermost protective features generally deal with the control of actual hazard attributes (*e g* , quantity, parameters) The middle layer of protective features generally deals with the first containment or confinement barrier around the actual hazard (*e g* , container, package) The outermost layer generally deals with the final set of confinement barriers, configurations, or controls (*e g* , structure, separation, inspection) The positioning of the protective features in a layering scheme is ultimately based on analyst judgment However, the actual positioning is not as important as the concept of layers of defense (*i e* , multiple protective features to control the hazard)

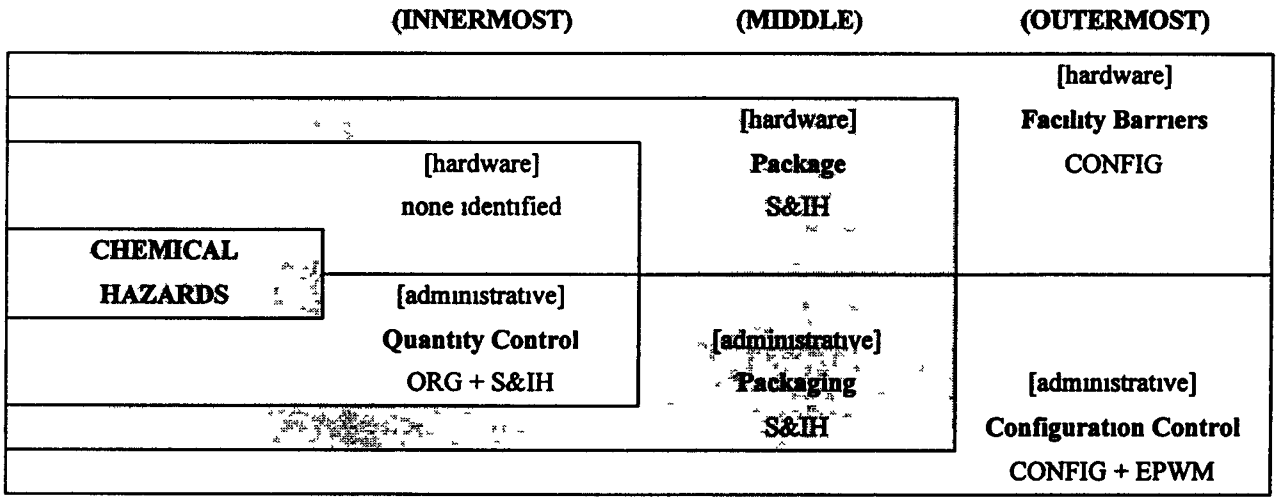

Figure 3 Credited Layers of Defense for Chemical Hazards

The purpose of each protective feature identified in Figure 3 is summarized below

- **Package** This protective feature is identified in Table 56 as an attribute of the S&IH SMP and maintains the assumptions of the Safety Analysis that chemicals are contained in standard packages,

- **Facility Barriers** This protective feature is implied in Table 56 as an attribute of the CONFIG SMP and maintains the assumptions of the Safety Analysis that chemicals remain separated from radioactive materials (*e g*, are separated by walls in the facility),

- **Quantity Control** This protective feature is identified in Table 56 as an attribute of both the ORG and the S&IH SMPs and maintains the assumptions of the Safety Analysis that chemicals pose no risk to the CW or the public due, in part, to the limited quantities of the chemicals,

- **Packaging** This protective feature is implied in Table 56 as an attribute of the S&IH SMP and maintains the assumptions of the Safety Analysis that chemicals are packaged appropriately, and

- **Configuration Control** This protective feature is identified in Table 56 as an attribute of both the CONFIG and the EPWM SMPs and maintains the assumptions of the Safety Analysis that chemicals remain separated from radioactive materials and

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from other incompatible hazardous chemicals (*e g*, are kept in separate locations in the facility)

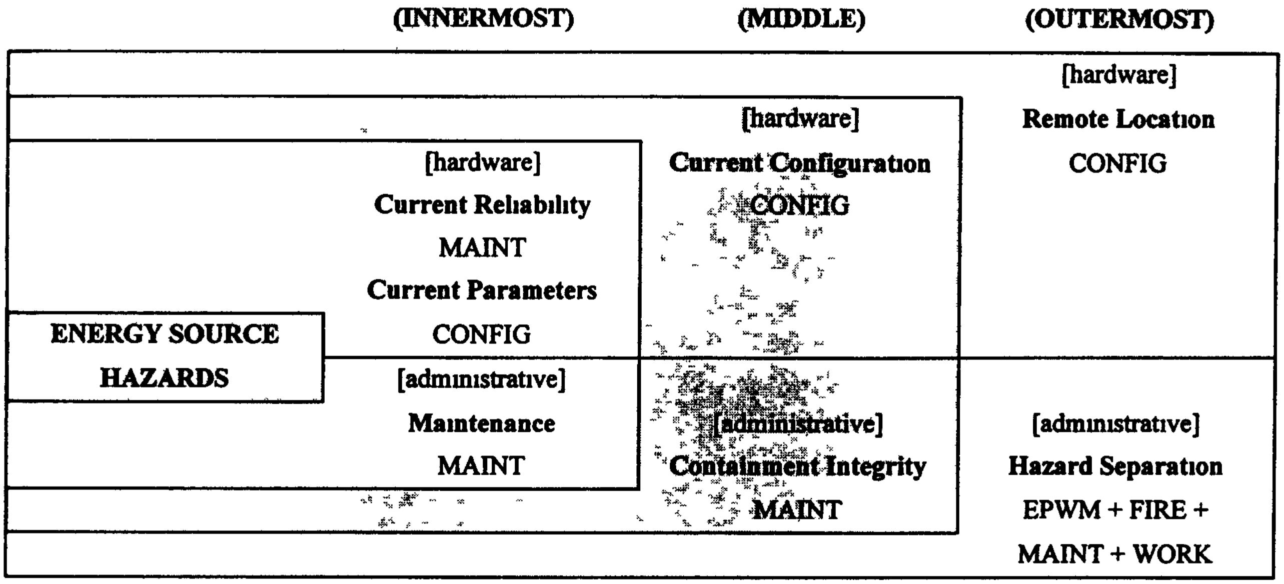

Figure 4 Credited Layers of Defense for Energy Source Hazards

The purpose of each protective feature identified in Figure 4 is summarized below

- **Current Reliability** This protective feature is identified in Table 56 as an attribute of the MAINT SMP and maintains the assumptions of the Safety Analysis that Electric Heaters are as reliable as past experience indicates such that the rate of fire ignition from the hazard does not increase significantly,

- **Current Parameters** This protective feature is identified in Table 56 as an attribute of the CONFIG SMP and maintains the assumptions of the Safety Analysis that Heated Water and Compressed Air hazards remain at relatively low temperatures and pressures, respectively,

- **Current Configuration** This protective feature is identified in Table 56 as an attribute of the CONFIG SMP and maintains the assumptions of the Safety Analysis that numerous energy source hazards remain physically separated from other hazards (*e g*, electric equipment, compressors, fans remain in their current locations),

- **Remote Location** This protective feature is identified in Table 56 as an attribute of the CONFIG SMP and maintains the assumptions of the Safety Analysis that the X-ray Device remains separated and shielded from the CW and the public,

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- **Maintenance** This protective feature is identified in Table 56 as an attribute of the MAINT SMP and maintains the assumptions of the Safety Analysis that the insulation associated with Electric Heater hazards are maintained such that the rate of fire ignition from the hazard remains consistent with past experience,

- **Containment Integrity** This protective feature is identified in Table 56 as an attribute of the MAINT SMP and maintains the assumptions of the Safety Analysis that confinements and containments associated with fuels are maintained, and

- **Hazard Separation** This protective feature is identified in Table 56 as an attribute of the EPWM, the FIRE, the MAINT, and the WORK SMPs and maintains the assumptions of the Safety Analysis that energy source hazards remain separated from radioactive materials and from other hazards (*e g*, waste containers are not stored next to energy sources, combustibles are not placed next to ignition sources, energy source tools are not used in close proximity to hazardous materials unless necessary)

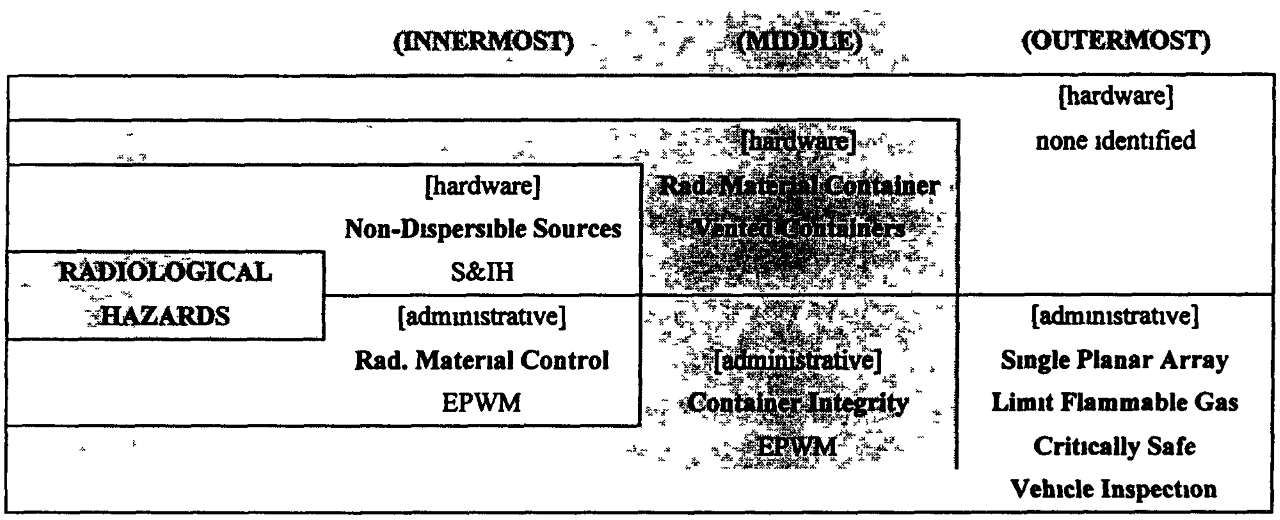

Figure 5 Credited Layers of Defense for Radiological Hazards

The purpose of each protective feature identified in Figure 5 is summarized below

- **Non-Dispersible Sources** This protective feature is identified in Table 56 as an attribute of the S&IH SMP and maintains the assumptions of the Safety Analysis that radioactive source material is sealed in a non-dispersible package configuration,

- **Rad. Material Container** This protective feature is identified in Table 65 and applies to the design of Type B shipping containers, POC containers, and metal waste containers to ensure that radioactive material containers perform under accident conditions as assumed in the Safety Analysis,

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- **Vented Containers** This protective feature is identified in Table 65 and applies to metal waste containers with hydrogen generation potential to reduce the likelihood, in the Safety Analysis, of the buildup of explosive concentrations of hydrogen gas in the container,

- **Rad. Material Control** This protective feature is implied in Table 56 as an attribute of the EPWM SMP and maintains the assumptions of the Safety Analysis that the drum crushing operation has limited exposure to radioactive material by restricting the level of contamination on drums to be crushed,

- **Container Integrity** This protective feature is identified in Table 56 as an attribute of the EPWM SMP and maintains the assumptions of the Safety Analysis that no significant Contamination hazards are expected due to prohibiting the opening of radioactive material containers,

- **Single Planar Array** This protective feature is identified in Table 65 and applies to Type B shipping containers containing Pyrophoric Materials to restrict container storage to single planar arrays (*i e*, no stacking) to preclude Pyrophoric Material container breach due to drops from stacks in the Safety Analysis,

- **Limit Flammable Gas** This protective feature is identified in Table 65 and applies to Type B shipping containers in vaults to restrict the use of flammable gases in the vault while SNM is present to preclude flammable gas explosions from impacting Type B shipping containers in vaults in the Safety Analysis,

- **Critically Safe** This protective feature is identified in Table 65 as an attribute of the CRIT SMP and applies to Type B shipping containers and metal waste containers to preclude the occurrence of a criticality event in the Safety Analysis as a result of the rearrangement of intact containers,

- **Vehicle Inspection** This protective feature is identified in Table 65 and applies to Type B shipping container and waste container Transport Vehicles to reduce the likelihood, in the Safety Analysis, that vehicle fires can occur by regular maintenance and inspection of the vehicles

4.3.4 Worker Safety

All of the protective features shown on Figure 3, Figure 4, and Figure 5 provide protection for the IW except for the X-ray Device **Remote Location** protective feature shown on Figure 4 In addition, the Worker Control attributes of the SMPs identified in Table 56 are specifically credited for providing protection for the IW, as discussed below In general, the Site SMPs listed in Chapter 3, *Safety Management Programs*, of the FSAR are credited with providing the set of controls necessary to protect the IW from Standard Industrial Hazards Most of the controls necessary to protect the CW and the public from Non-Standard Industrial Hazards will apply to IW protection as well In addition, specific controls to protect the IW from high risk accident scenarios may be identified in the accident analysis portion of the Safety Analysis

The Worker Control protective features identified in Table 56 are defined as attributes of specific SMPs A total of ten SMPs were specifically identified as providing IW protection against Standard Industrial Hazards Note many SMPs provide a supporting control function (*i e*, work in conjunction with other SMPs to control a hazard) The control functions identified in the lists below are not qualified as to the level of control associated with the corresponding SMP That is, if a SMP works with another SMP to provide a control, the control will not be listed differently from controls over which the SMP is a sole provider The identified SMPs and the control functions provided are

1 Organization and Management (ORG) - controls use of some radioactive material Sealed Sources by locking doors, controls use of the X-ray Device by locking doors, monitors hazardous system configuration and operation, restricts entry to various facilities by locking doors, restricts entry into various hazardous areas, controls the quantities of hazardous materials entering the complex, controls hazardous material storage areas, controls location of specific hazardous materials, monitors areas, and controls the current configuration,

2 Configuration Management (CONFIG) - controls the current configuration and maintains existing hazardous material facility separation from other facilities,

3 Environmental Protection and Waste Management (EPWM) - restricts the opening of any radioactive material containers, controls the current form of certain waste materials (*e g*, Beryllium), specifies the appropriate containers to be used for certain wastes, and surveys various hazardous areas,

4 Fire Protection (FIRE) - inspects systems with the potential to ignite or exacerbate a fire,

5 Safety and Industrial Hygiene (S&IH) - specifies and verifies any barrier requirements around high voltage electrical systems, specifies and verifies any insulation requirements for electrical or thermal hazards, specifies any personnel protective equipment requirements associated with specific jobs and hazards, provides adequate postings and labels for hazards, specifies any lockout/tagout requirements associated with specific jobs and hazards, specifies appropriate containers to be used for certain hazardous materials or equipment, specifies any shielding requirements for radiation sources, inspects radioactive material sources and the X-ray Device, specifies appropriate requirements on the use of certain equipment, specifies pressure relief requirements for and inspects fluid systems, inspects various hazardous systems and tools, specifies location of electrical equipment relative to working areas, verifies the integrity of enclosures on various components, inspects component controllers, controls the quantities of hazardous materials entering the complex, specifies and verifies implementation of any restrictions on areas involving hazards, and controls the current form of certain materials (*e g*, Beryllium)

6 Maintenance (MAINT) - evaluates the use of radioactive material sources in the performance of work and evaluates any maintenance work for hazards,

7 Quality Assurance (QA) - verifies radioactive material source package meets specifications when brought on Site,

8 Radiation Protection (RAD) - specifies appropriate packaging to be used for radioactive material sources, specifies any shielding requirements for radiation sources, specifies any personnel protective equipment requirements associated with specific jobs involving radiation hazards, inspects radioactive material sources and the X-ray Device, provides adequate postings for radiation hazards, determines As-Low-As-Reasonably-Achievable (ALARA) requirements during work planning, specifies appropriate requirements on the use of radiation equipment, verifies confinement of radioactive materials and contamination, performs area radiation surveys, and develops Radiation Work Permits,

9 Training (TRAIN) - specifies training requirements and provides appropriate training for the conduct of work, and

10 Work Control (WORK) - controls the concurrent conduct of work involving hazardous materials or equipment

4.3.5 Environmental Protection

Environmental risks are primarily addressed by protection of the CW and the public That is, if controls are put in place to protect the CW and the public from exposures to radioactive and hazardous materials, the environment, for the most part, is also protected Given that the primary hazards to external receptors associated with the Building 991 Complex deal with radioactive materials in the facilities rather than dealing with processes or operations that utilize various other hazardous materials, the primary threat to the environment would come from the radioactive materials Therefore, protecting the CW and the public from releases of radioactive materials also protects the environment

Some non-radioactive hazardous materials are found in the Building 991 Complex and are discussed in Section 4 1 8, *Toxic, Hazardous, or Noxious Materials (Hazard/Energy Source 9)* All materials with a defined TPQ or TQ are expected to be below the defined thresholds Some hazardous materials exceed a defined RQ value but have activities related to the abatement and removal of the materials or have specific programs and controls covering material use or removal Therefore, the non-radioactive, hazardous material risks to the environment are expected to be small and further investigation of the risks to the environment would not be expected to define any controls beyond those already required by the programs dealing with the hazardous materials

4.3.6 Bounding Scenario Selection

The selection of bounding accident scenarios is performed to reduce the number of scenarios that must be evaluated in the accident analysis The intent of the process is to eliminate the evaluation of scenarios that would not provide (1) any additional information about accident progression, (2) any additional understanding of facility risk, or (3) any additional control requirements associated with safe operations Sets of accident scenarios that satisfy these criteria are termed "similar" accident scenarios in this evaluation Similar accident scenarios can be bounding in a number of ways

1 the bounding scenario could have a higher frequency (*e g*, a drop of a drum during an intentional forklift movement may be more likely than and bound a drop of a drum from the top of a stack due to a forklift inadvertent contact),

2 the bounding scenario could have a higher source term (*e g*, a breach of a single TRU waste box holding 320 grams may bound a breach of a single TRU waste drum holding 200 grams),

3 the bounding scenario could have both a higher frequency and a higher source term (*e g*, a drop of a TRU waste box holding 320 grams during an intentional forklift movement may be more likely than and bound a drop of a TRU waste drum holding 200 grams from the top of a stack due to a forklift inadvertent contact), or

4 the bounding scenario could have an equivalent source term and frequency (*e g*, a drop of a drum due to a vehicle inadvertent contact during the conduct of a maintenance activity may bound a drop of a drum due to a vehicle inadvertent contact during the conduct of a construction activity)

The selection process for bounding scenarios examines the 164 scenario combinations (including low risk scenarios) for each of the above four situations The process splits the evaluations for internal events and external events in support of the accident analysis for natural phenomena and external events Also, the examination evaluates scenarios within the seven general types of accident scenarios rather than attempting to bound scenarios with scenarios of a different type. Under this approach, this process examines.

- 0 internal event material fires,
- 28 internal event facility fires,
- 65 internal event spills,
- 52 internal event punctures,
- 2 internal event container explosions,
- 11 internal event facility explosions, and
- 6 internal event criticalities

In addition, the process has the potential to examine 0 external event material fires, 19 external event facility fires, 31 external event spills, 7 external event punctures, 0 external event container explosions, 11 external event facility explosions, and 6 external event criticalities, however, the process actually focuses on individual natural phenomena and external events (*e g*, seismic, high wind, aircraft crash) rather than the scenario combinations (*e g*, SPILL-3-B / Type B container / breach due to structural member impacts / Hazard 13H - seismic, wind, tornado, heavy snow, aircraft crash)

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4.3.6.1 Bounding Material Fire Scenarios Determination

This section deleted since it was assumed that pyrophoric materials will not be brought into the facility and that SNM containers complied with Type B shipping container requirements and with the requirements of procedure 1-W89-HSP-31 11 (Ref 20) These assumptions made material fires in the Building 991 Complex *not credible* events

Table 66 Deleted

4.3.6.2 Bounding Facility Fire Scenarios Determination

As indicated above, 28 facility fire scenario combinations have been identified as yielding Risk Class I, II, or III accident scenarios Facility fires deal with accidents involving the exposure of radioactive material containers to fires of various types Four types of radioactive material containers may be impacted by facility fires (1) POC containers containing up to 1,255 WG Pu equivalent grams, (2) TRU waste containers containing up to 200 grams in drums and 320 grams in boxes, (3) metal LLW containers containing up to 3 grams, and (4) wooden LLW containers containing up to 3 grams POC and waste containers are initially assumed to be located in analyzed storage locations within facilities of the Building 991 Complex and the wooden containers also are initially assumed to be located outside

Table 67 presents the 28 credible facility fire scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible facility fire scenario number, the general type of fire associated with the scenario (to allow for determinations of similarity), the type of container associated with the scenario, the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 67 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

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Table 67 Credible Facility Fire Scenarios

SCENARIO	SCENARIO FIRE TYPE	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
FFIRE-1-C	direct container exposure to intense flame	LLWm	E	L	FFIRE-1-G	MAR = 3 grams (single metal container), same MAR - same frequency, equivalent scenario
FFIRE-1-C	direct container exposure to intense flame	TRU	E	H	FFIRE-1-G	MAR = 320 grams (single container), same MAR - same frequency, equivalent scenario
FFIRE-1-C	direct container exposure to intense flame	POC	E	H	FFIRE-1-G	MAR = 1,255 grams (single container), same MAR - same frequency, equivalent scenario
FFIRE-1-F	direct container exposure to intense flame	LLWm	E	L	FFIRE-1-G	MAR = 3 grams (single metal container), same MAR - same frequency, equivalent scenario
FFIRE-1-F	direct container exposure to intense flame	TRU	E	H	FFIRE-1-G	MAR = 320 grams (single container), same MAR - same frequency, equivalent scenario
FFIRE-1-F	direct container exposure to intense flame	POC	E	H	FFIRE-1-G	MAR = 1,255 grams (single container), same MAR - same frequency, equivalent scenario
FFIRE-1-G	direct container exposure to intense flame	LLWm	E	L	FFIRE B1 LLWm	MAR = 3 grams (single metal container)
FFIRE-1-G	direct container exposure to intense flame	TRU	E	H	FFIRE B1 TRU	MAR = 320 grams (single container)
FFIRE-1-G	direct container exposure to intense flame	POC	E	H	FFIRE B1 POC	MAR = 1,255 grams (single container)
FFIRE-2-C	transport vehicle fire at the dock	LLWm	E	H	FFIRE B2 LLWm	MAR = vehicle metal LLW inventory
FFIRE-2-C	transport vehicle fire at the dock	TRU	E	H	FFIRE B2 TRU	MAR = vehicle TRU waste inventory
FFIRE-3-A	area fire involving combustibles	LLWm	U	L	FFIRE-4-G	MAR = contamination < 3 grams, lower MAR - same frequency, more resistant container
FFIRE-3-C	area fire involving combustibles	LLWm	U	H	FFIRE-4-G	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container
FFIRE-3-C	area fire involving combustibles	TRU	U	H	FFIRE-3-G	MAR = area TRU waste inventory, same MAR - same frequency, equivalent scenario
FFIRE-3-E	area fire involving combustibles	LLWm	U	H	FFIRE-4-G	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container
FFIRE-3-E	area fire involving combustibles	TRU	U	H	FFIRE-3-G	MAR = area TRU waste inventory, same MAR - same frequency, equivalent scenario
FFIRE-3-F	area fire involving combustibles	LLWm	U	H	FFIRE-4-G	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container

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Table 67 Credible Facility Fire Scenarios

SCENARIO	SCENARIO FIRE TYPE	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
FFIRE-3-F	area fire involving combustibles	TRU	U	H	FFIRE-3-G	MAR = area TRU waste inventory, same MAR - same frequency, equivalent scenario
FFIRE-3-G	area fire involving combustibles	LLWm	U	H	FFIRE-4-G	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container
FFIRE-3-G	area fire involving combustibles	TRU	U	H	FFIRE B3 TRU	MAR = area TRU waste inventory
FFIRE-3-H	area fire involving combustibles	LLWm	U	H	FFIRE-4-G	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container
FFIRE-3-H	area fire involving combustibles	TRU	U	H	FFIRE-3-G	MAR = area TRU waste inventory, same MAR - same frequency, equivalent scenario
FFIRE-4-A	area fire involving combustibles	LLWw	U	L	FFIRE-4-G	MAR = contamination < 3 grams, lower MAR - same frequency, equivalent scenario
FFIRE-4-C	area fire involving combustibles	LLWw	U	H	FFIRE-4-G	MAR = area wooden LLW inventory, same MAR - same frequency, equivalent scenario
FFIRE-4-E	area fire involving combustibles	LLWw	U	H	FFIRE-4-G	MAR = area wooden LLW inventory, same MAR - same frequency, equivalent scenario
FFIRE-4-F	area fire involving combustibles	LLWw	U	H	FFIRE-4-G	MAR = area wooden LLW inventory, same MAR - same frequency, equivalent scenario
FFIRE-4-G	area fire involving combustibles	LLWw	U	H	FFIRE B3 LLW	MAR = area wooden LLW inventory
FFIRE-4-H	area fire involving combustibles	LLWw	U	H	FFIRE-4-G	MAR = area wooden LLW inventory, same MAR - same frequency, equivalent scenario

Based on the results of Table 67, three bounding facility fire scenarios are identified, all of which deal with at least two container types and one of which deals with three container types For the LLW containers FFIRE-B1-LLWm is an *extremely unlikely* event dealing with a metal LLW container being subjected to direct flame impingement from a torch (*e g*, propane) that is used to bound two other equivalent scenarios, FFIRE-B2-LLWm is an *extremely unlikely* event dealing with an entire transport vehicle load of metal LLW containers being involved in a transport vehicle fire at a Building 991 dock that is not used to bound any other scenarios, and FFIRE-B3-LLW is an *unlikely* event dealing with an entire room, area, or transport vehicle inventory of LLW containers being involved in a fire that is used to bound eleven other equivalent or similar scenarios, some of which have lower MAR values It cannot be predetermined whether a transport vehicle inventory of LLW containers is greater than a storage area inventory of LLW containers FFIRE-B3-LLW potentially deals with both types of event since FFIRE-4 includes Hazard 5H (Transport Vehicles) and Hazard 13F (Combustibles)

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Rather than trying to make a determination of the bounding situation, both cases will be addressed Also, the *extremely unlikely* direct container exposure bounding event, FFIRE-B1-LLWm, can be included as part of the *unlikely* area fire that may include a single container or multiple containers Therefore, two bounding scenarios dealing with LLW containers are proposed B-FFIRE-1(LLW), an *unlikely* event dealing with storage area fires involving wooden LLW containers (covers area inventory metal LLW container and single metal or wooden container events), and B-FFIRE-2(LLW), an *extremely unlikely* event dealing with transport vehicle fires involving wooden LLW containers (covers transport vehicle fire metal LLW container events)

For the TRU waste containers FFIRE-B1-TRU is an *extremely unlikely* event dealing with a TRU waste container being subjected to direct flame impingement from a torch (*e g*, propane) that is used to bound two other equivalent scenarios, FFIRE-B2-TRU is an *extremely unlikely* event dealing with an entire transport vehicle load of TRU waste containers being involved in a transport vehicle fire at a Building 991 dock that is not used to bound any other scenarios, and FFIRE-B3-TRU is an *unlikely* event dealing with an entire room or area inventory of TRU waste containers being involved in a fire that is used to bound four other equivalent scenarios The *extremely unlikely* direct container exposure bounding event, FFIRE-B1-TRU, can be included as part of the *unlikely* area fire that may include a single container or multiple containers Therefore, two bounding scenarios dealing with TRU waste containers are proposed. B-FFIRE-1(TRU), an *unlikely* event dealing with storage area fires involving TRU containers (covers single container events), and B-FFIRE-2(TRU), an *extremely unlikely* event dealing with transport vehicle fires involving TRU waste containers

For the POC containers FFIRE-B1-POC is an *extremely unlikely* event dealing with a POC container being subjected to direct flame impingement from a torch (*e g*, propane) that is used to bound two other equivalent scenarios The bounding scenario will be re-labeled as B-FFIRE-3

In summary, facility fire bounding scenarios are

- B-FFIRE-1 involving the *unlikely* impact of a facility fire on a waste storage area inventory (for each of LLW and TRU waste containers),

B-FFIRE-1 carries forward the following assumptions, protective features, and requirements

R3 - controls in place to ensure that containers are *extremely unlikely* to be directly exposed to flammable gas flames,

- B-FFIRE-2 involving the *extremely unlikely* impact of a transport vehicle fire at the dock on a transport vehicle inventory (for each of LLW and TRU waste containers),

B-FFIRE-2 carries forward the following assumptions, protective features, and requirements

A12 - fires *unlikely* for transport vehicles, and

A14 - transport vehicle fires *unlikely* to propagate to cargo,

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- B-FFIRE-3 involving the *extremely unlikely* impact of a direct flame impingement torch fire on a single POC container,

B-FFIRE-3 carries forward the following assumptions, protective features, and requirements

F17 - flammable gas containers *unlikely* to be breached during use, and

R8 - controls in place to ensure that fires are *unlikely* to occur in waste storage areas

4.3.6.3 Bounding Spill Scenarios Determination

As indicated above, 65 spill scenario combinations have been identified as yielding Risk Class I, II, III, or IV accident scenarios Spills deal with accidents involving the impact of radioactive material containers with various objects leading to container failure Five types of radioactive material containers may be subjected to spill events (1) Type B shipping containers containing 6,000 grams of oxide, (2) POC containers containing up to 1,255 WG Pu equivalent grams, (3) TRU waste containers containing up to 200 grams in drums and 320 grams in boxes, (4) metal LLW containers containing up to 3 grams, and (5) wooden LLW containers containing up to 3 grams The Type B shipping containers may be located in Room 150 (vault) or may be in transit between the dock at Room 170 and Room 150 POC and waste containers may be located in analyzed storage locations within facilities of the Building 991 Complex and the wooden containers also may be located outside

Table 68 presents the 65 credible spill scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible spill scenario number, the general container failure mechanism associated with the scenario (to allow for determinations of similarity), the type of container associated with the scenario, the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 68 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

In the analysis of the spill scenarios, container breaches by any means are equivalent as far as material releases are concerned Containers can fall during movement from raised forklift tines, can fall from the upper tiers of stacks due to stack impacts, can be impacted by vehicles during movement or while being stored, and can be impacted by structural members while being stored All of these events breach the container in a similar manner and will be evaluated using the same ARRF value Therefore, the failure mechanisms shown in Table 68 are all equivalent

Table 68 Credible Spill Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS	BOUNDING SCENARIO	REMARKS
SPILL-1-A	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A), more resistant container; similar scenario
SPILL-1-C	container breach due to drop or impact	LLWm	A	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - same frequency, more resistant container; equivalent scenario
SPILL-1-C	container breach due to drop or impact	TRU	A	H	**SPILL B1 TRU**	MAR = 320 to 800 grams (pallet or box)
SPILL-1-D	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, invokes SPILL-1-C
SPILL-1-D	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), invokes SPILL-1-C
SPILL-1-E	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, invokes SPILL-1-C
SPILL-1-E	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), invokes SPILL-1-C
SPILL-1-F	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, invokes SPILL-1-C
SPILL-1-F	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), invokes SPILL-1-C
SPILL-1-G	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, invokes SPILL-1-C
SPILL-1-G	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), invokes SPILL-1-C
SPILL-2-A	container breach due to drop or impact	LLWm	E	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (E vs A), more resistant container
SPILL-2-C	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant container; similar scenario
SPILL-2-C	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), similar scenario
SPILL-2-D	container breach due to drop or impact	LLWm	E	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes SPILL-2-C
SPILL-2-D	container breach due to drop or impact	TRU	E	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (E vs A), invokes SPILL-2-C
SPILL-2-E	container breach due to drop or impact	LLWm	E	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes SPILL-2-C

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Table 68 Credible Spill Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
SPILL-2-E	container breach due to drop or impact	TRU	E	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (E vs A), invokes SPILL-2-C
SPILL-2-F	container breach due to drop or impact	LLWm	E	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes SPILL-2-C
SPILL-2-F	container breach due to drop or impact	TRU	E	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (E vs A), invokes SPILL-2-C
SPILL-2-G	container breach due to drop or impact	LLWm	E	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes SPILL-2-C
SPILL-2-G	container breach due to drop or impact	TRU	E	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (E vs A), invokes SPILL-2-C
SPILL-3-A	container breach due to drop or impact	LLWm	U[1]	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A), more resistant container
SPILL-3-B	container breach due to drop or impact	Type B	E	H	**SPILL B2 Type B**	MAR = inventory of Type B containers
SPILL-3-C	container breach due to drop or impact	LLWm	U[1]	M	SPILL-7-C	MAR = area metal LLW inventory, potentially same MAR - same frequency, more resistant container
SPILL-3-C	container breach due to drop or impact	TRU	U[1]	H	**SPILL B2 TRU**	MAR = area TRU waste inventory
SPILL-3-C	container breach due to drop or impact	POC	E[2]	H	**SPILL B2 POC**	MAR = area POC inventory
SPILL-4-A	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
SPILL-4-A	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-4-B	container breach due to drop or impact	LLWm	A	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - same frequency, more resistant container; unintentional impact
SPILL-4-B	container breach due to drop or impact	TRU	A	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - same frequency, unintentional impact vs intentional move
SPILL-4-C	container breach due to drop or impact	LLWm	A	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - same frequency, more resistant container, unintentional impact
SPILL-4-C	container breach due to drop or impact	TRU	A	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - same frequency, unintentional impact vs intentional move
SPILL-4-D	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact

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Table 68 Credible Spill Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
SPILL-4-D	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-4-E	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
SPILL-4-E	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-4-F	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
SPILL-4-F	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-4-G	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
SPILL-4-G	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-4-H	container breach due to drop or impact	LLWm	U	L	SPILL-5-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
SPILL-4-H	container breach due to drop or impact	TRU	U	H	SPILL-1-C	MAR = 320 to 800 grams (pallet or box), same MAR - lower frequency (U vs A), unintentional impact vs. intentional move
SPILL-5-A	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A)
SPILL-5-C	container breach due to drop or impact	LLWw	A	L	**SPILL B1 LLW**	MAR = 3 grams (single wooden container)
SPILL-5-D	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-5-C
SPILL-5-E	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-5-C
SPILL-5-F	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-5-C
SPILL-5-G	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-5-C
SPILL-6-A	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A)
SPILL-6-C	container breach due to drop or impact	LLWw	A	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - same frequency, similar scenario

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Table 68 Credible Spill Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
SPILL-6-D	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-6-C
SPILL-6-E	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-6-C
SPILL-6-F	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-6-C
SPILL-6-G	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes SPILL-6-C
SPILL-7-A	container breach due to drop or impact	LLWw	U[1]	L	SPILL-5-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A)
SPILL-7-C	container breach due to drop or impact	LLWw	U[1]	M	SPILL B2 LLW	MAR = area wooden LLW inventory
SPILL-8-A	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-8-B	container breach due to drop or impact	LLWw	A	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - same frequency, unintentional impact vs intentional move
SPILL-8-C	container breach due to drop or impact	LLWw	A	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - same frequency, unintentional impact vs intentional move
SPILL-8-D	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-8-E	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs. A), unintentional impact vs intentional move
SPILL-8-F	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-8-G	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
SPILL-8-H	container breach due to drop or impact	LLWw	U	L	SPILL-5-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move

[1]event frequency changed to *unlikely* since prior *anticipated* frequency was associated with a natural phenomena event,
[2]event frequency changed to *extremely unlikely* since prior *unlikely* frequency was associated with a natural phenomena event

Based on the results of Table 68, two bounding spill scenarios are identified, one of which deals with two container types and one of which deals with four container types For the LLW containers SPILL-B1-LLW is an *anticipated* event dealing with a single wooden LLW container (LLW box containing up to 3 grams bounds a pallet (4 drums) of LLW drums

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(0 5 grams each) totalıng up to 2 grams) beıng dropped or ımpacted that ıs used to bound forty-one other equıvalent or sımılar scenarıos, some of whıch have lower frequencıes and some of whıch have lower MAR values, and SPILL-B2-LLW ıs an *unlıkely* event dealıng wıth an entıre room or area ınventory of LLW contaıners beıng dropped or ımpacted that ıs used to bound one other equıvalent scenarıo Therefore, two boundıng scenarıos dealıng wıth LLW contaıners are proposed B-SPILL-1(LLW), an *antıcıpated* event dealıng wıth a spıll of a sıngle wooden LLW contaıner (covers sıngle metal LLW contaıner events), and B-SPILL-2(LLW), an *unlıkely* event dealıng wıth an entıre room or area ınventory of wooden LLW contaıners (covers area ınventory metal LLW contaıner events) beıng dropped or ımpacted due to structure faılures

For the TRU waste contaıners SPILL-B1-TRU ıs an *antıcıpated* event dealıng wıth a sıngle TRU waste contaıner or pallet (TRU waste box contaınıng up to 320 grams or pallet (4 drums) of TRU drums (200 grams each) totalıng up to 800 grams) being dropped or ımpacted that ıs used to bound seventeen other equıvalent or sımılar scenarios, some of whıch have lower frequencıes, and SPILL-B2-TRU ıs an *unlıkely* event dealıng wıth an entıre room or area ınventory of TRU waste contaıners beıng dropped or ımpacted that ıs not used to bound any other scenarıos Therefore, two boundıng scenarıos dealıng wıth TRU waste contaıners are proposed B-SPILL-1(TRU), an *antıcıpated* event dealıng wıth a spıll of a sıngle TRU waste contaıner or a pallet of TRU waste contaıners (whıchever has a boundıng MAR value - drop of a pallet may not faıl all contaıners and, dependıng on the number of contaıners on the pallet that are breached, the TRU waste box may present a boundıng MAR value), and B-SPILL-2(TRU), an *unlıkely* event dealıng wıth an entıre room or area ınventory of TRU waste containers beıng dropped or ımpacted due to structure faılures

For the POC contaıners SPILL-B2-POC ıs an *extremely unlıkely* event dealıng wıth an entıre room or area ınventory of POC contaıners beıng dropped or impacted due to structural faılures that ıs not used to bound any other scenarıos The boundıng scenario wıll be re-labeled as B-SPILL-2(POC)

For the Type B shıppıng contaıners SPILL-B2-Type B ıs an *extremely unlıkely* event dealıng wıth an entıre room or area ınventory of Type B shıppıng contaıners beıng dropped or ımpacted due to structural faılures that ıs not used to bound any other scenarıos. Gıven the stagıng locatıon of Type B shıppıng contaıners ın Room 150, there ıs no susceptibılıty of the stagıng locatıon to eıther Hazard 13C (Tunnel Degradatıon and Leakage) or Hazard 13E (Floor Loadıng) sınce the room ıs not near a tunnel and ıs not located over an open area below the floorıng Transıent exposure to Hazard 13E by a materıal handlıng vehıcle carryıng Type B shıppıng contaıners ıs not consıdered a suffıcıent load to faıl the floor for the areas ınvolved ın the movement Therefore, SPILL-B2-Type B ıs not consıdered a scenarıo of concern

In summary, spıll boundıng scenarıos are

- B-SPILL-1 ınvolvıng the *antıcıpated* spıll of a sıngle waste contaıner or a sıngle pallet of waste contaıners (for each of LLW and TRU waste contaıners),

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B-SPILL-1 carries forward the following assumptions, protective features, and requirements

A1 - containers *unlikely* to be moved under certain activities,

A3 - structural failures are *unlikely* events,

A6 - certain activities *unlikely* to use material handling equipment,

F3 - metal waste containers *unlikely* to be breached by non-tine vehicle impacts, and

R1 - stacking of Type B shipping containers is prohibited

- B-SPILL-2 involving the *unlikely* spill of an entire room or area of waste containers resulting from facility structural failures (for each of LLW and TRU waste containers) and involving the *extremely unlikely* spill of an entire room or area of POC containers resulting from facility structural failures,

B-SPILL-2 carries forward the following assumptions, protective features, and requirements

A3 - structural failures are *unlikely* events; and

F7 - POC containers *unlikely* to be breached by structural member impacts

4.3.6.4 Bounding Puncture Scenarios Determination

As indicated above, 52 puncture scenario combinations have been identified as yielding Risk Class I, II, III, or IV accident scenarios Punctures deal with accidents involving the impact of radioactive material containers with forklift tines or structural members leading to container and container internal packaging failures Five types of radioactive material containers may be subjected to puncture events (1) Type B shipping containers containing 6,000 grams of oxide, (2) POC containers containing up to 1,255 WG Pu equivalent grams, (3) TRU waste containers containing up to 200 grams in drums and 320 grams in boxes, (4) metal LLW containers containing up to 3 grams, and (5) wooden LLW containers containing up to 3 grams The Type B shipping containers may be located in Room 150 (vault) or may be in transit between the dock at Room 170 and Room 150 POC and waste containers may be located in analyzed storage locations within facilities of the Building 991 Complex and the wooden containers also may be located outside

Table 69 presents the 52 credible puncture scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible puncture scenario number, the general container failure mechanism associated with the scenario (to allow for determinations of similarity), the type of container associated with the scenario, the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 69 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

In the analysis of the puncture scenarios, container punctures by any means are equivalent as far as material releases are concerned Containers can be impacted by forklift tines prior to being moved, can be inadvertently impacted by forklift tines while being stored, and can be impacted by structural members while being stored Each of these events puncture the container in a similar manner and will be evaluated using the same ARRF value Therefore, the failure mechanisms shown in Table 69 are all equivalent

Table 69 Credible Puncture Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS	BOUNDING SCENARIO	REMARKS
PUNCT-1-A	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = contamination < 3 grams, lower MAR - lower frequency (E vs A), more resistant container; similar scenario
PUNCT-1-B	container puncture due to impact	Type B	E	H	PUNCT B1 Type B	MAR = 6,000 grams (single container)
PUNCT-1-C	container puncture due to impact	LLWm	U	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, equivalent scenario
PUNCT-1-C	container puncture due to impact	TRU	U	H	PUNCT B1 TRU	MAR = 320 to 400 grams (pallet with 2 drums impacted or box)
PUNCT-1-C	container puncture due to impact	POC	E	H	PUNCT B1 POC	MAR = 1,255 grams (single container)
PUNCT-1-D	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes PUNCT-1-C
PUNCT-1-D	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), invokes PUNCT-1-C
PUNCT-1-E	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes PUNCT-1-C
PUNCT-1-E	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), invokes PUNCT-1-C
PUNCT-1-F	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes PUNCT-1-C
PUNCT-1-F	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), invokes PUNCT-1-C
PUNCT-1-G	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, invokes PUNCT-1-C
PUNCT-1-G	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), invokes PUNCT-1-C

Table 69 Credible Puncture Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
PUNCT-2-A	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-A	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move
PUNCT-2-B	container puncture due to impact	LLWm	U	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
PUNCT-2-B	container puncture due to impact	TRU	U	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-2-B	container puncture due to impact	POC	E	H	PUNCT-1-C	MAR = 1,255 grams (single container), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-2-C	container puncture due to impact	LLWm	U	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (U vs A), more resistant, unintentional impact
PUNCT-2-C	container puncture due to impact	TRU	U	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-2-C	container puncture due to impact	POC	E	H	PUNCT-1-C	MAR = 1,255 grams (single container), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-2-D	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-D	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move
PUNCT-2-E	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-E	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move
PUNCT-2-F	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-F	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move
PUNCT-2-G	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-G	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move
PUNCT-2-H	container puncture due to impact	LLWm	E	L	PUNCT-4-C	MAR = 3 grams (single metal container), same MAR - lower frequency (E vs A), more resistant, unintentional impact
PUNCT-2-H	container puncture due to impact	TRU	E	H	PUNCT-1-C	MAR = 320 to 400 grams (pallet or box), same MAR - lower frequency (E vs U), unintentional impact vs intentional move

Table 69 Credible Puncture Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS	BOUNDING SCENARIO	REMARKS
PUNCT-3-A	container puncture due to impact	LLWm	U[1]	L	PUNCT-4-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A), more resistant container
PUNCT-3-B	container puncture due to impact	Type B	E	H	**PUNCT B2 Type B**	MAR = inventory of Type B containers
PUNCT-3-C	container puncture due to impact	LLWm	U[1]	M	PUNCT-6-C	MAR = room metal LLW inventory, potentially same MAR - same frequency, more resistant container
PUNCT-3-C	container puncture due to impact	TRU	U[1]	H	**PUNCT B2 TRU**	MAR = room TRU waste inventory
PUNCT-3-C	container puncture due to impact	POC	E[2]	H	**PUNCT B2 POC**	MAR = room POC inventory
PUNCT-4-A	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A)
PUNCT-4-C	container puncture due to impact	LLWw	A	L	**PUNCT B1 LLW**	MAR = 3 grams (single wooden container)
PUNCT-4-D	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes PUNCT-4-C
PUNCT-4-E	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes PUNCT-4-C
PUNCT-4-F	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes PUNCT-4-C
PUNCT-4-G	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), invokes PUNCT-4-C
PUNCT-5-A	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
PUNCT-5-B	container puncture due to impact	LLWw	A	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-5-C	container puncture due to impact	LLWw	A	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - same frequency, unintentional impact vs intentional move
PUNCT-5-D	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
PUNCT-5-E	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
PUNCT-5-F	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move

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Table 69 Credible Puncture Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
PUNCT-5-G	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
PUNCT-5-H	container puncture due to impact	LLWw	U	L	PUNCT-4-C	MAR = 3 grams (single wooden container), same MAR - lower frequency (U vs A), unintentional impact vs intentional move
PUNCT-6-A	container puncture due to impact	LLWw	U[1]	L	PUNCT-4-C	MAR = contamination < 3 grams, lower MAR - lower frequency (U vs A)
PUNCT-6-C	container puncture due to impact	LLWw	U[1]	M	PUNCT B2 LLW	MAR = room wooden LLW inventory

[1]event frequency changed to *unlikely* since prior *anticipated* frequency was associated with a natural phenomena event,
[2]event frequency changed to *extremely unlikely* since prior *unlikely* frequency was associated with a natural phenomena event

Based on the results of Table 69, two bounding puncture scenarios are identified, both of which deal with four container types For the LLW containers PUNCT-B1-LLW is an *anticipated* event dealing with a single wooden LLW container (LLW box containing up to 3 grams bounds a pallet (2 drums impacted) of LLW drums (0 5 grams each) totaling up to 1 gram) being impacted and punctured by a forklift tine that is used to bound twenty-nine other equivalent or similar scenarios, some of which have lower frequencies and some of which have lower MAR values, and PUNCT-B2-LLW is an *unlikely* event dealing with an entire room inventory of LLW containers being impacted and punctured by structural members that is used to bound one other equivalent scenario Therefore, two bounding scenarios dealing with LLW containers are proposed B-PUNCT-1(LLW), an *anticipated* event dealing with the forklift tine puncture of a single wooden LLW container (covers single metal LLW container events), and B-PUNCT-2(LLW), an *unlikely* event dealing with an entire room inventory of wooden LLW containers (covers area inventory metal LLW container events) being impacted by structural members due to structure failures

For the TRU waste containers PUNCT-B1-TRU is an *unlikely* event dealing with a single TRU waste container or pallet (TRU waste box containing up to 320 grams or pallet (2 drums impacted) of TRU drums (200 grams each) totaling up to 400 grams) being impacted and punctured by a forklift tine that is used to bound twelve other equivalent or similar scenarios, some of which have lower frequencies, and PUNCT-B2-TRU is an *unlikely* event dealing with an entire room inventory of TRU waste containers being impacted and punctured by structural members that is not used to bound any other scenarios Therefore, two bounding scenarios dealing with TRU waste containers are proposed B-PUNCT-1(TRU), an *unlikely* event dealing with a puncture of a single TRU waste container or a pallet of TRU waste containers (whichever has a bounding MAR value), and B-PUNCT-2(TRU), an *unlikely* event dealing with an entire room inventory of TRU waste containers being impacted by structural members due to structure failures

For the POC containers PUNCT-B1-POC is an *extremely unlikely* event dealing with a single POC container being impacted and punctured by a forklift tine that is used to bound two other similar scenarios, and PUNCT-B2-POC is an *extremely unlikely* event dealing with an entire room inventory of POC containers being impacted and punctured by structural members that is not used to bound any other scenarios Therefore, two bounding scenarios dealing with POC containers are proposed B-PUNCT-1(POC), an *extremely unlikely* event dealing with a puncture of a single POC container, and B-PUNCT-2(POC), an *extremely unlikely* event dealing with an entire room inventory of POC containers being impacted by structural members due to structure failures

For the Type B shipping containers PUNCT-B1-Type B is an *extremely unlikely* event dealing with a single Type B shipping container being impacted and punctured by a forklift tine that is not used to bound any other scenarios, and PUNCT-B2-Type B is an *extremely unlikely* event dealing with an entire room inventory of Type B shipping containers being impacted and punctured by structural members that is not used to bound any other scenarios Given the staging location of Type B shipping containers in Room 150, there is no susceptibility of the staging location to either Hazard 13C (Tunnel Degradation and Leakage) since the room is not near a tunnel Therefore, PUNCT-B2-Type B is not considered a scenario of concern

In summary, puncture bounding scenarios are

- B-PUNCT-1 involving the *anticipated* puncture of a single LLW container, involving the *unlikely* puncture of a single TRU waste container or a single pallet of TRU waste containers, and involving the *extremely unlikely* puncture of a single container (for each of Type B shipping and POC containers),

B-PUNCT-1 carries forward the following assumptions, protective features, and requirements

A1 - containers *unlikely* to be moved under certain activities,

A3 - structural failures are *unlikely* events,

A6 - certain activities *unlikely* to use material handling equipment,

F10 - metal waste containers *unlikely* to be breached by forklift tine impacts,

F11 - Type B shipping containers *extremely unlikely* to be breached by forklift tine impacts, and

F12 - POC containers *extremely unlikely* to be breached by forklift tine impacts,

- B-PUNCT-2 involving the *unlikely* puncture of an entire room or area of waste containers resulting from facility structural failures (for each of LLW and TRU waste containers) and involving the *extremely unlikely* puncture of an entire room or area of POC containers resulting from facility structural failures,

B-PUNCT-2 carries forward the following assumptions, protective features, and requirements

A3 - structural failures are *unlikely* events, and

F7 - POC containers *unlikely* to be breached by structural member impacts

4.3.6.5 Bounding Container Explosion Scenarios Determination

As indicated above, 2 container explosion scenario combinations have been identified as yielding Risk Class II accident scenarios Container explosions deal with accidents involving the accumulation of hydrogen (*e g*, from radiolysis) inside sealed metal waste containers with subsequent hydrogen ignition and container overpressure Only one type of container is considered to be a candidate for both susceptibility to internal explosions and hydrogen accumulation in sufficient quantities to yield a credible explosion scenario TRU waste containers containing up to 200 grams in drums and 320 grams in boxes TRU waste containers may be located in analyzed storage locations within facilities of the Building 991 Complex

Table 70 presents the 2 credible container explosion scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible container explosion scenario number, the general container failure mechanism associated with the scenario (to allow for determinations of similarity), the type of container associated with the scenario (only one identified), the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 70 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

In the analysis of the container explosion scenarios, container breach due to internal explosions by any means are equivalent as far as material releases are concerned The hydrogen explosion can be initiated by static charge buildup in the container or contact with vehicles or personnel holding a static charge The hazard evaluation process did not attempt to cover every mechanism for hydrogen explosion initiation (*i e*, only the WASTE and SURV activities were considered in the evaluation process rather than considering all activities as potential spark initiators) because the initiation mechanism is impossible to control Static charge can build up for a variety of reasons and inadvertent contact with charged vehicles, components, or personnel cannot be avoided Controls must focus on preventing the hydrogen accumulation rather than the hydrogen explosion ignition Therefore, examination of all activities in the hazard evaluation process was not performed and the failure mechanisms shown in Table 70 are all equivalent

Table 70 Credible Container Explosion Scenarios

SCENARIO	FAILURE MECHANISM	TYPE	FREQ	CONS.	BOUNDING SCENARIO	REMARKS
CEXPLO-1-C	sealed container contact with spark	TRU	E	H	**CEXPLO B1 TRU**	MAR = 320 grams (largest container)
CEXPLO-1-D	sealed container contact with spark	TRU	E	H	CEXPLO-1-C	MAR = 320 grams (largest container), same MAR - same frequency, equivalent scenario

Based on the results of Table 70, one bounding container explosion scenario is identified For the TRU waste containers CEXPLO-B1-TRU is an *extremely unlikely* event dealing with a

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TRU waste container internal hydrogen explosion that is used to bound one other equivalent scenario The bounding scenario is re-labeled as B-CEXPLO-1

In summary, the container explosion bounding scenario is

- B-CEXPLO-1 involving the *extremely unlikely* explosion of a TRU waste container due to hydrogen generation and accumulation,

B-CEXPLO-1 carries forward the following assumptions, protective features, and requirements

F13 - container internal explosions *extremely unlikely* events due to vents

4.3.6.6 Bounding Facility Explosion Scenarios Determination

As indicated above, 11 facility explosion scenario combinations have been identified as yielding Risk Class II, III, or IV accident scenarios Facility explosions deal with accidents involving the exposure of radioactive material containers to explosions of various types Three types of radioactive material containers may be impacted by facility explosions (1) TRU waste containers containing up to 200 grams in drums and 320 grams in boxes, (2) metal LLW containers containing up to 3 grams, and (3) wooden LLW containers containing up to 3 grams Waste containers are initially assumed to be located in analyzed storage locations within facilities of the Building 991 Complex and the wooden containers also are initially assumed to be located outside

Table 71 presents the 11 credible facility explosion scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible facility explosion scenario number, the general type of explosion associated with the scenario (only one type identified - flammable gas explosion), the type of container associated with the scenario, the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 71 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

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Table 71 Credible Facility Explosion Scenarios

SCENARIO	EXPLOSION TYPE	TYPE	FREQ	CONS	BOUNDING SCENARIO	REMARKS
FEXPLO-1-A	flammable gas explosion	LLWm	E	L	FEXPLO-2-G	MAR = contamination < 3 grams, lower MAR - same frequency, more resistant container; equivalent scenario
FEXPLO-1-C	flammable gas explosion	LLWm	E	M	FEXPLO-2-G	MAR = room metal LLW inventory, potentially same MAR - same frequency, more resistant, equivalent scenario
FEXPLO-1-C	flammable gas explosion	TRU	E	H	FEXPLO-1-G	MAR = room TRU waste inventory, same MAR - same frequency, equivalent scenario
FEXPLO-1-F	flammable gas explosion	LLWm	E	M	FEXPLO-2-G	MAR = room metal LLW inventory, potentially same MAR - same frequency, more resistant, equivalent scenario
FEXPLO-1-F	flammable gas explosion	TRU	E	H	FEXPLO-1-G	MAR = room TRU waste inventory, same MAR - same frequency, equivalent scenario
FEXPLO-1-G	flammable gas explosion	LLWm	E	M	FEXPLO-2-G	MAR = room metal LLW inventory, potentially same MAR - same frequency, more resistant, equivalent scenario
FEXPLO-1-G	flammable gas explosion	TRU	E	H	**FEXPLO B1 TRU**	MAR = room TRU waste inventory
FEXPLO-2-A	flammable gas explosion	LLWw	E	L	FEXPLO-2-G	MAR = contamination < 3 grams, lower MAR - same frequency, equivalent scenario
FEXPLO-2-C	flammable gas explosion	LLWw	E	M	FEXPLO-2-G	MAR = room wooden LLW inventory, same MAR - same frequency, equivalent scenario
FEXPLO-2-F	flammable gas explosion	LLWw	E	M	FEXPLO-2-G	MAR = room wooden LLW inventory, same MAR - same frequency, equivalent scenario
FEXPLO-2-G	flammable gas explosion	LLWw	E	M	**FEXPLO B1 LLW**	MAR = room wooden LLW inventory

Based on the results of Table 71, one bounding facility explosion scenario is identified, which deals with two container types For the LLW containers FEXPLO-B1-LLW is an *extremely unlikely* event dealing with a room inventory of wooden LLW containers being subjected to an explosion in the room (from flammable gases like propane or natural gas) that is used to bound seven other equivalent or similar scenarios, some of which have lower MAR values The bounding scenario is re-labeled as B-FEXPLO-1(LLW) and covers similar metal LLW container events

For the TRU waste containers FEXPLO-B1-TRU is an *extremely unlikely* event dealing with a room inventory of TRU waste containers being subjected to an explosion in the room (from flammable gases like propane or natural gas) that is used to bound two other equivalent scenarios The bounding scenario is re-labeled as B-FEXPLO-1(TRU)

In summary, facility explosion bounding scenario is

- B-FEXPLO-1 involving the *extremely unlikely* impact of a facility explosion on a waste storage area inventory (for each of LLW and TRU waste containers),

B-FEXPLO-1 carries forward the following assumptions, protective features, and requirements

A4 - natural gas system failures leading to explosions are *extremely unlikely* events,

F17 - flammable gas containers *unlikely* to be breached during use, and

R9 - controls in place such that flammable gas explosions are *unlikely* to occur in waste storage areas

4.3.6.7 Bounding Criticality Scenarios Determination

As indicated above, 6 criticality scenario combinations have been identified as yielding Risk Class I or II accident scenarios Criticality events deal with accidents involving the rearrangement of radioactive material containers or the radioactive material in the containers into configurations yielding a criticality Three types of radioactive material containers may be involved in criticality events (1) Type B shipping containers containing 6,000 grams of oxide, (2) POC containers containing up to 1,255 WG Pu equivalent grams, and (3) TRU waste containers containing up to 200 grams in drums and 320 grams in boxes The Type B shipping containers may be located in Room 150 (vault) or may be in transit between the dock at Room 170 and Room 150 POC and TRU waste containers may be located in analyzed storage locations within facilities of the Building 991 Complex

Table 72 presents the 6 credible criticality scenario combinations The table extracts information from Table 62 and Table 63 and indicates the credible criticality scenario number, the general mechanism for inducing the criticality associated with the scenario (to allow for determinations of similarity), the type of container associated with the scenario, the scenario initial estimate of frequency, and the scenario initial estimate of consequence The last two columns of Table 72 either indicate the bounding scenario number (if bounded) and a corresponding brief discussion of why the scenario is bounded or indicate the bounding scenario label (if the scenario is bounding) and the corresponding MAR

Table 72 Credible Criticality Scenarios

SCENARIO	CRITICALITY MECHANISM	TYPE	FREQ	CONS	BOUNDING SCENARIO	REMARKS
CRIT-4-B	rearrangement due to structure impacts	Type B	E	H	CRIT B1 Type B	MAR = inventory of Type B containers
CRIT-4-C	rearrangement due to structure impacts	TRU	U[1]	H	CRIT B1 TRU	MAR = area TRU waste inventory
CRIT-4-C	rearrangement due to structure impacts	POC	E[2]	H	CRIT B1 POC	MAR = area POC inventory
CRIT-5-C	rearrangement due to explosion	TRU	E	H	CRIT-5-G	MAR = room TRU waste inventory, same MAR - same frequency, equivalent scenario
CRIT-5-F	rearrangement due to explosion	TRU	E	H	CRIT-5-G	MAR = room TRU waste inventory, same MAR - same frequency, equivalent scenario
CRIT-5-G	rearrangement due to explosion	TRU	E	H	CRIT B2 TRU	MAR = room TRU waste inventory

[1]event frequency changed to *unlikely* since prior *anticipated* frequency was associated with a natural phenomena event,
[2]event frequency changed to *extremely unlikely* since prior *unlikely* frequency was associated with a natural phenomena event

Based on the results of Table 72, two bounding criticality scenarios are identified, one of which deals with three container types and one of which deals with one container type For the TRU waste containers CRIT-B1-TRU is an *unlikely* event dealing with an entire room or area inventory of TRU waste containers being dropped or impacted leading to a rearrangement of the radioactive material and subsequent criticality that is not used to bound any other scenarios, and CRIT-B2-TRU is an *extremely unlikely* event dealing with an entire room inventory of TRU waste containers being subjected to an explosion in the room (from flammable gases like propane or natural gas) that is used to bound two other equivalent scenarios Therefore, two bounding scenarios dealing with TRU waste containers are proposed B-CRIT-1(TRU), an *unlikely* event dealing with an entire room or area inventory of TRU waste containers being dropped or impacted due to structure failures, and B-CRIT-2(TRU), an *extremely unlikely* event dealing with an entire room inventory of TRU waste containers being subjected to a flammable gas explosion in the room

For the POC containers CRIT-B1-POC is an *extremely unlikely* event dealing with an entire room or area inventory of POC containers being dropped or impacted leading to a rearrangement of the radioactive material and subsequent criticality that is not used to bound any other scenarios The bounding scenario is re-labeled as B-CRIT-1(POC)

For the Type B shipping containers CRIT-B1-Type B is an *extremely unlikely* event dealing with an entire room inventory of Type B shipping containers being dropped or impacted leading to a rearrangement of the radioactive material and subsequent criticality that is not used to bound any other scenarios Given the staging location of Type B shipping containers in Room 150, there is no susceptibility of the staging location to either Hazard 13C (Tunnel Degradation and Leakage) or Hazard 13E (Floor Loading) since the room is not near a tunnel and is not located over an open area below the flooring Transient exposure to Hazard 13E by a material handling vehicle carrying Type B shipping containers is not considered a sufficient load to fail the floor for the areas involved in the movement Therefore, CRIT-B1-Type B is not considered a scenario of concern

In summary, criticality bounding scenarios are

- B-CRIT-1 involving the *unlikely* rearrangement of an entire room or area of TRU waste containers resulting from facility structural failures leading to a criticality and involving the *extremely unlikely* rearrangement of an entire room or area of POC containers resulting from facility structural failures leading to a criticality,

B-CRIT-1 carries forward the following assumptions, protective features, and requirements

A3 - structural failures are *unlikely* events,

F6 - Type B shipping containers *unlikely* to be breached by structural member impacts, and

F7 - POC containers *unlikely* to be breached by structural member impacts,

- B-CRIT-2 involving the *extremely unlikely* rearrangement of an entire room of TRU waste containers resulting from a flammable gas explosion leading to a criticality,

B-CRIT-2 carries forward the following assumptions, protective features, and requirements

A4 - natural gas system failures leading to explosions are *extremely unlikely* events,

F17 - flammable gas containers *unlikely* to be breached during use, and

R9 - controls in place such that flammable gas explosions are *unlikely* to occur in waste storage areas

4.3.6.8 Natural Phenomena and External Event Scenarios Determination

As indicated earlier, the process for natural phenomena and external event scenario selection will focus on individual natural phenomena and external events rather than on scenario combinations, as was done for the internal event bounding scenario selections When evaluating individual natural phenomena and external events, consideration should be given to the credible scenario combinations displayed in hazard evaluation summary, Table 64 For each natural phenomena and external event considered in the hazard evaluation, a set of scenarios can be identified Table 73 presents the credible scenario combinations for each natural phenomena and external event based on the hazard evaluation process and information extracted from Table 62 and Table 63 The order of natural phenomena and external event presentation follows the order of presentation in Table 8 Scenario combination frequency adjustments have been made per the

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natural phenomena/external event frequency assumptions presented in Table 61 For the purposes of Table 73, natural phenomena events are considered to be external events

Table 73 is intended to be used during the evaluation of natural phenomena and external events as guidance in the type of accident scenarios that can be initiated by the events Many of the scenario combinations listed in the table can ultimately be combined in the evaluation of the external event due to worst case assumptions For example, it would not be necessary to evaluate wooden LLW containers being impacted by an external event if the same event can impact TRU waste containers in the facility

Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ.	CONS.
Seismic	Facility fire - full inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) not modified to reflect seismic (U)]	FFIRE-3-A	LLW	U	L
		FFIRE-3-C	LLW TRU	U U	H H
		FFIRE-3-E	LLW TRU	U U	H H
		FFIRE-3-F	LLW TRU	U U	H H
		FFIRE-3-G	LLW TRU	U U	H H
		FFIRE-3-H	LLW TRU	U U	H H
Seismic	Facility fire - full inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) not modified to reflect seismic (U)]	FFIRE-4-A	LLW	U	L
		FFIRE-4-C	LLW	U	H
		FFIRE-4-E	LLW	U	H
		FFIRE-4-F	LLW	U	H
		FFIRE-4-G	LLW	U	H
		FFIRE-4-H	LLW	U	H
Seismic	Structural impact induced spill - full inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect seismic (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	SPILL-3-A	LLW	U	L
		SPILL-3-B	Type B	E	H
		SPILL-3-C	LLW TRU POC	U U E	M H H

Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
Seismic	Stack topple induced spill - stacked container inventory [Combination B / C frequencies initially set using internal event (A) adjusted down one frequency bin to reflect seismic (U), Combination A / D / E / F / G / H frequencies initially set using internal event (U) not modified to reflect seismic (U)]	SPILL-4-A	LLW TRU	U U	L H
		SPILL-4-B	LLW TRU	U U	L H
		SPILL-4-C	LLW TRU	U U	L H
		SPILL-4-D	LLW TRU	U U	L H
		SPILL-4-E	LLW TRU	U U	L H
		SPILL-4-F	LLW TRU	U U	L H
		SPILL-4-G	LLW TRU	U U	L H
		SPILL-4-H	LLW TRU	U U	L H
Seismic	Structural impact induced spill - full inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect seismic (U)]	SPILL-7-A	LLW	U	L
		SPILL-7-C	LLW	U	M
Seismic	Stack topple induced spill - stacked container inventory [Combination B / C frequencies initially set using internal event (A) adjusted down one frequency bin to reflect seismic (U), Combination A / D / E / F / G / H frequencies initially set using internal event (U) not modified to reflect seismic (U)]	SPILL-8-A	LLW	U	L
		SPILL-8-B	LLW	U	L
		SPILL-8-C	LLW	U	L
		SPILL-8-D	LLW	U	L
		SPILL-8-E	LLW	U	L
		SPILL-8-F	LLW	U	L
		SPILL-8-G	LLW	U	L
		SPILL-8-H	LLW	U	L
Seismic	Structural impact induced puncture - full inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect seismic (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	PUNCT-3-A	LLW	U	L
		PUNCT-3-B	Type B	E	H
		PUNCT-3-C	LLW TRU POC	U U E	M H H

Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS.
Seismic	Structural impact induced puncture - full inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect seismic (U)]	PUNCT-6-A	LLW	U	L
		PUNCT-6-C	LLW	U	M
Seismic	Facility explosion induced spill - room inventory [Combination F / G frequencies initially set using internal event (E) not modified to reflect seismic impact on natural gas (E)]	FEXPLO-1-A	LLW	E	L
		FEXPLO-1-C	LLW	E	M
			TRU	E	H
		FEXPLO-1-F	LLW	E	M
			TRU	E	H
		FEXPLO-1-G	LLW	E	M
			TRU	E	H
Seismic	Facility explosion induced spill - room inventory [Combination F / G frequencies initially set using internal event (E) not modified to reflect seismic impact on natural gas (E)]	FEXPLO-2-A	LLW	E	L
		FEXPLO-2-C	LLW	E	M
		FEXPLO-2-F	LLW	E	M
		FEXPLO-2-G	LLW	E	M
Seismic	Structural impact induced spill and subsequent criticality - full inventory [Combination C frequency initially set using high wind (A) adjusted down one frequency bin to reflect seismic (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	CRIT-4-B	Type B	E	H
		CRIT-4-C	TRU	U	H
			POC	E	H
Seismic	Facility explosion induced spill and subsequent criticality - room inventory [Combination F / G frequencies initially set using internal event (E) not modified to reflect seismic impact on natural gas (E)]	CRIT-5-C	TRU	E	H
		CRIT-5-F	TRU	E	H
		CRIT-5-G	TRU	E	H

Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ.	CONS.
Lightning	Facility fire - partial inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) not modified to reflect combination of lightning and combustibles (U)]	FFIRE-3-A	LLW	U	L
		FFIRE-3-C	LLW	U	H
			TRU	U	H
		FFIRE-3-E	LLW	U	H
			TRU	U	H
		FFIRE-3-F	LLW	U	H
			TRU	U	H
		FFIRE-3-G	LLW	U	H
			TRU	U	H
		FFIRE-3-H	LLW	U	H
			TRU	U	H
Lightning	Facility fire - partial inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) not modified to reflect combination of lightning and combustibles (U)]	FFIRE-4-A	LLW	U	L
		FFIRE-4-C	LLW	U	H
		FFIRE-4-E	LLW	U	H
		FFIRE-4-F	LLW	U	H
		FFIRE-4-G	LLW	U	H
		FFIRE-4-H	LLW	U	H
Lightning	Facility explosion induced spill - room inventory [Combination A / C frequencies initially set using seismic event (E) not modified to reflect lightning strike and rupture of natural gas line (E), Combination F / G frequencies initially set using internal event (E) not modified to reflect lightning strike and rupture of natural gas line (E)]	FEXPLO-1-A	LLW	E	L
		FEXPLO-1-C	LLW	E	M
			TRU	E	H
		FEXPLO-1-F	LLW	E	M
			TRU	E	H
		FEXPLO-1-G	LLW	E	M
			TRU	E	H
Lightning	Facility explosion induced spill - room inventory [Combination A / C frequencies initially set using seismic event (E) not modified to reflect lightning strike and rupture of natural gas line (E), Combination F / G frequencies initially set using internal event (E) not modified to reflect lightning strike and rupture of natural gas line (E)]	FEXPLO-2-A	LLW	E	L
		FEXPLO-2-C	LLW	E	M
		FEXPLO-2-F	LLW	E	M
		FEXPLO-2-G	LLW	E	M

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Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
Lightning	Facility explosion induced spill and subsequent criticality - room inventory [Combination C frequency initially set using seismic event (E) not modified to reflect lightning strike and rupture of natural gas line (E), Combination F / G frequencies initially set using internal event (E) not modified to reflect lightning strike and rupture of natural gas line (E)]	CRIT-5-C CRIT-5-F CRIT-5-G	TRU TRU TRU	E E E	H H H
Aircraft Crash	Fuel fire - partial inventory [Combination C frequency initially set using internal event (U) adjusted down one frequency bin to reflect aircraft crash (E) and then not modified for fire propagation]	FFIRE-2-C	LLW TRU	E E	H H
Aircraft Crash	Facility fire - partial inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) adjusted down one frequency bin to reflect aircraft crash (E)]	FFIRE-4-A FFIRE-4-C FFIRE-4-E FFIRE-4-F FFIRE-4-G FFIRE-4-H	LLW LLW LLW LLW LLW LLW	E E E E E E	L H H H H H
Aircraft Crash	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down two frequency bins to reflect aircraft crash (E), Combination B frequency initially set using seismic (U) adjusted down one frequency bin to reflect aircraft crash (E), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	SPILL-3-A SPILL-3-B SPILL-3-C	LLW Type B LLW TRU POC	E NC E E NC	L none M H none

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Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ.	CONS
Aircraft Crash	Stack topple induced spill - partial stacked container inventory [Combination B / C frequencies initially set using internal event (A) adjusted down two frequency bins to reflect aircraft crash (E), Combination A / D / E / F / G / H frequencies initially set using internal event (U) adjusted down one frequency bin to reflect aircraft crash (E)]	SPILL-4-A	LLW TRU	E E	L H
		SPILL-4-B	LLW TRU	E E	L H
		SPILL-4-C	LLW TRU	E E	L H
		SPILL-4-D	LLW TRU	E E	L H
		SPILL-4-E	LLW TRU	E E	L H
		SPILL-4-F	LLW TRU	E E	L H
		SPILL-4-G	LLW TRU	E E	L H
		SPILL-4-H	LLW TRU	E E	L H
Aircraft Crash	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down two frequency bins to reflect aircraft crash (E)]	SPILL-7-A	LLW	E	L
		SPILL-7-C	LLW	E	M
Aircraft Crash	Stack topple induced spill - partial stacked container inventory [Combination B / C frequencies initially set using internal event (A) adjusted down two frequency bins to reflect aircraft crash (E), Combination A / D / E / F / G / H frequencies initially set using internal event (U) adjusted down one frequency bin to reflect aircraft crash (E)]	SPILL-8-A	LLW	E	L
		SPILL-8-B	LLW	E	L
		SPILL-8-C	LLW	E	L
		SPILL-8-D	LLW	E	L
		SPILL-8-E	LLW	E	L
		SPILL-8-F	LLW	E	L
		SPILL-8-G	LLW	E	L
		SPILL-8-H	LLW	E	L
Aircraft Crash	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down two frequency bins to reflect aircraft crash (E), Combination B frequency initially set using seismic (U) adjusted down one frequency bin to reflect aircraft crash (E), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	PUNCT-3-A	LLW	E	L
		PUNCT-3-B	Type B	NC	none
		PUNCT-3-C	LLW TRU POC	E E NC	M H none

Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
Aircraft Crash	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down two frequency bins to reflect aircraft crash (E)]	PUNCT-6-A PUNCT-6-C	LLW LLW	E E	L M
Aircraft Crash	No impact [Aircraft crash induced facility explosion involving natural gas or propane leading to spill or criticality is considered to be not credible due to fire related to the event reducing the likelihood of gas buildup to explosive levels and the likelihood of an aircraft crash (E)]	FEXPLO-1 FEXPLO-2 CRIT-5		NC	none
Aircraft Crash	Structural impact induced spill and subsequent criticality - partial inventory [Combination C frequency initially set using high wind (A) adjusted down two frequency bins to reflect aircraft crash (E), Combination B frequency initially set using seismic (U) adjusted down one frequency bin to reflect aircraft crash (E), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	CRIT-4-B CRIT-4-C	Type B TRU POC	NC E NC	none H none
Range Fire	Facility fire - partial inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) adjusted down one frequency bin to reflect range fire (E)]	FFIRE-3-A FFIRE-3-C FFIRE-3-E FFIRE-3-F FFIRE-3-G FFIRE-3-H	LLW LLW TRU LLW TRU LLW TRU LLW TRU LLW TRU	E E E E E E E E E E E	L H H H H H H H H H H
Range Fire	Facility fire - partial inventory [Combination A / C / E / F / G / H frequencies initially set using internal event (U) adjusted down one frequency bin to reflect range fire (E)]	FFIRE-4-A FFIRE-4-C FFIRE-4-E FFIRE-4-F FFIRE-4-G FFIRE-4-H	LLW LLW LLW LLW LLW LLW	E E E E E E	L H H H H H

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Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
High Wind	Structural impact induced spill - partial inventory [Combination B frequency initially set using seismic (U) not modified to reflect high wind in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	SPILL-3-A	LLW	A	L
		SPILL-3-B	Type B	E (vault)	H
		SPILL-3-C	LLW	A	M
			TRU	A	H
			POC	U	H
High Wind	Structural impact induced spill - partial inventory	SPILL-7-A	LLW	A	L
		SPILL-7-C	LLW	A	M
High Wind	Structural impact induced puncture - partial inventory [Combination B frequency initially set using seismic (U) not modified to reflect high wind in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	PUNCT-3-A	LLW	A	L
		PUNCT-3-B	Type B	E (vault)	H
		PUNCT-3-C	LLW	A	M
			TRU	A	H
			POC	U	H
High Wind	Structural impact induced puncture - partial inventory	PUNCT-6-A	LLW	A	L
		PUNCT-6-C	LLW	A	M
High Wind	No impact [High wind induced facility explosion involving natural gas or propane leading to spill or criticality is considered to be not credible due to dispersal of gas by the wind reducing the likelihood of gas buildup to explosive levels]	FEXPLO-1 FEXPLO-2 CRIT-5		NC	none
High Wind	Structural impact induced spill and subsequent criticality - partial inventory [Combination B frequency initially set using seismic (U) not modified to reflect high wind in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	CRIT-4-B	Type B	E (vault)	H
		CRIT-4-C	TRU	A	H
			POC	U	H
Tornado	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect tornado (U), Combination B frequency initially set using seismic (U) not modified to reflect tornado (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	SPILL-3-A	LLW	U	L
		SPILL-3-B	Type B	E	H
		SPILL-3-C	LLW	U	M
			TRU	U	H
			POC	E	H
Tornado	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect tornado (U)]	SPILL-7-A	LLW	U	L
		SPILL-7-C	LLW	U	M

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Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
Tornado	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect tornado (U), Combination B frequency initially set using seismic (U) not modified to reflect tornado (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	PUNCT-3-A PUNCT-3-B PUNCT-3-C	LLW Type B LLW TRU POC	U E U U E	L H M H H
Tornado	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) adjusted down one frequency bin to reflect tornado (U)]	PUNCT-6-A PUNCT-6-C	LLW LLW	U U	L M
Tornado	No impact [Tornado induced facility explosion involving natural gas or propane leading to spill or criticality is considered to be not credible due to dispersal of gas by the wind reducing the likelihood of gas buildup to explosive levels]	FEXPLO-1 FEXPLO-2 CRIT-5		NC	none
Tornado	Structural impact induced spill and subsequent criticality - partial inventory [Combination C frequency initially set using high wind (A) adjusted down one frequency bin to reflect tornado (U), Combination B frequency initially set using seismic (U) not modified to reflect tornado (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	CRIT-4-B CRIT-4-C	Type B TRU POC	E U E	H H H
Heavy Rain	No impact [Heavy rain induced spill from toppling waste container stacks is considered to be not credible due to low energy associated with flooding events and resistance of stacks to toppling]	SPILL-4 SPILL-8		NC	none
Flooding	No impact [Flooding induced spill from toppling waste container stacks is considered to be not credible due to low energy associated with flooding events and resistance of stacks to toppling]	SPILL-4 SPILL-8		NC	none
Heavy Snow	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) not modified to reflect heavy snow (A), Combination B frequency initially set using seismic (U) not modified to reflect heavy snow in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	SPILL-3-A SPILL-3-B SPILL-3-C	LLW Type B LLW TRU POC	A E (vault) A A U	L H M H H

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Table 73 Natural Phenomena and External Event Credible Scenario Combinations

EE	SCENARIO DESCRIPTION AND COMMENTS	SCENARIO	TYPE	FREQ	CONS
Heavy Snow	Structural impact induced spill - partial inventory [Combination A / C frequencies initially set using high wind (A) not modified to reflect heavy snow (A)]	SPILL-7-A SPILL-7-C	LLW LLW	A A	L M
Heavy Snow	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) not modified to reflect heavy snow (A), Combination B frequency initially set using seismic (U) not modified to reflect heavy snow in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	PUNCT-3-A PUNCT-3-B PUNCT-3-C	LLW Type B LLW TRU POC	A E (vault) A A U	L H M H H
Heavy Snow	Structural impact induced puncture - partial inventory [Combination A / C frequencies initially set using high wind (A) not modified to reflect heavy snow (A)]	PUNCT-6-A PUNCT-6-C	LLW LLW	A A	L M
Heavy Snow	Structural impact induced spill and subsequent criticality - partial inventory [Combination C frequency initially set using high wind (A) not modified to reflect heavy snow (A), Combination B frequency initially set using seismic (U) not modified to reflect heavy snow in combination with area is a vault (U), Type B / POC container failure frequency additionally adjusted down one frequency bin due to strength]	CRIT-4-B CRIT-4-C	Type B TRU POC	E (vault) A U	H H H
Freezing	No impact [Freezing (and subsequent pipe break) induced spill from toppling waste container stacks is considered to be not credible due to low energy associated with flooding events and resistance of stacks to toppling]	SPILL-4 SPILL-8		NC	none

The following conclusions can be reached dealing with natural phenomena and external events based on the information presented in Table 73 and these results should be considered in the evaluation of accident scenarios associated with the events

- Seismic events have the potential to initiate (1) *unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving LLW and TRU waste containers, (3) *extremely unlikely* spill scenarios involving POC and Type B shipping containers, (4) *unlikely* puncture scenarios involving LLW and TRU waste containers, (5) *extremely unlikely* puncture scenarios involving POC and Type B shipping containers, (6) *extremely unlikely* facility explosion scenarios involving LLW and TRU waste containers, (7) *unlikely* criticality scenarios involving TRU waste containers, and (8) *extremely unlikely* criticality scenarios involving TRU waste, POC, and Type B shipping containers,

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- Lightning events have the potential to initiate (1) *unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* facility explosion scenarios involving LLW and TRU waste containers, and (3) *extremely unlikely* criticality scenarios involving TRU waste containers,

- Aircraft crash events have the potential to initiate (1) *extremely unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* spill scenarios involving LLW and TRU waste containers, (3) *extremely unlikely* puncture scenarios involving LLW and TRU waste containers, and (4) *extremely unlikely* criticality scenarios involving TRU waste containers,

- Range fire events have the potential to initiate (1) *extremely unlikely* facility fire scenarios involving LLW and TRU waste containers,

- High wind events have the potential to initiate (1) *anticipated* spill scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving POC containers, (3) *anticipated* puncture scenarios involving LLW and TRU waste containers, (4) *unlikely* puncture scenarios involving POC containers, (5) *anticipated* criticality scenarios involving TRU waste containers, (6) *unlikely* criticality scenarios involving POC containers, and (7) *extremely unlikely* criticality scenarios involving Type B shipping containers,

- Tornado events have the potential to initiate (1) *unlikely* spill scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* spill scenarios involving POC containers, (3) *unlikely* puncture scenarios involving LLW and TRU waste containers, (4) *extremely unlikely* puncture scenarios involving POC containers, (5) *unlikely* criticality scenarios involving TRU waste containers, and (6) *extremely unlikely* criticality scenarios involving POC and Type B shipping containers,

- Heavy rain events do not have a credible potential to initiate any scenarios (flooding scenarios have little impact due to lack of contamination),

- Flooding events do not have a credible potential to initiate any scenarios (flooding scenarios have little impact due to lack of contamination),

- Heavy snow events have the potential to initiate (1) *anticipated* spill scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving POC containers, (3) *extremely unlikely* spill scenarios involving Type B shipping containers, (4) *anticipated* puncture scenarios involving LLW and TRU waste containers, (5) *unlikely* puncture scenarios involving POC containers, (6) *extremely unlikely* puncture scenarios involving Type B shipping containers, (7) *anticipated* criticality scenarios involving TRU waste containers, (8) *unlikely* criticality scenarios involving POC containers, and (9) *extremely unlikely* criticality scenarios involving Type B shipping containers, and

- Freezing events do not have a credible potential to initiate any scenarios (flooding scenarios have little impact due to lack of contamination)

In the evaluation of natural phenomena and external event credible scenario combinations, multiple scenario combinations were determined to be not credible based on old and some new assumptions, protective features, and requirements Table 74 presents a listing of the new assumptions (coded by the letter "A") made, and new requirements (coded by the letter "R") specified in the determination of not credible natural phenomena and external events The scenarios to which each assumption or requirement applies are listed in the table along with the impact of the assumption or requirement

Table 74 New Assumptions/Requirements for External Event Not Credible Scenarios

#	ASSUMPTION/ REQUIREMENT	SCENARIO CODE	ASSUMPTION/REQUIREMENT IMPACT
A15	Natural gas or propane explosions are not expected to occur following an aircraft crash event due to the fire associated with the event preventing the buildup of gases to explosive levels	FEXPLO-1 [aircraft crash] FEXPLO-2 [aircraft crash] CRIT-5 [aircraft crash]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following an aircraft crash to *Beyond Extremely Unlikely*
A16	Natural gas or propane explosions are not expected to occur following high wind or tornado events due to the wind dispersal of the flammable gases preventing the buildup of gases to explosive levels	FEXPLO-1 [high wind] FEXPLO-2 [high wind] CRIT-5 [high wind] FEXPLO-1 [tornado] FEXPLO-2 [tornado] CRIT-5 [tornado]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following high wind or tornado events to *Beyond Extremely Unlikely*
A17	Forces associated with waste storage area flooding following heavy rain, flooding, or freezing induced flooding events are not expected to be sufficient to result in waste container stack toppling	SPILL-4 [heavy rain] SPILL-8 [heavy rain] SPILL-4 [flooding] SPILL-8 [flooding] SPILL-4 [freezing] SPILL-8 [freezing]	Reduces the likelihood of radioactive material container failure from scenarios dealing with flooding following heavy rain, flooding, or freezing induced flooding events to *Beyond Extremely Unlikely*

The assumptions, protective features, and requirements supporting the determination that a natural phenomena or external event scenario combination is not credible are identified, defined, and discussed in Table 62, Table 63, Table 73, and Table 74 Table 75 lists the 21 scenario combinations (*i e*, scenario label, container type, and external event) that were determined to be not credible along with the controls (from Table 61 and Table 74) that support and maintain that determination These identified controls must be included in the TSR control set for the Building 991 Complex

Table 75 Credited Protective Features and Requirements Yielding Not Credible Scenarios

SCENARIO CODE	TYPE	ASSUMPTION / FEATURE / REQUIREMENT	CONTROL
SPILL-3-B [aircraft crash], PUNCT-3-B [aircraft crash], CRIT-4-B [aircraft crash]	Type B	A3/F6 - *unlikely* to be breached by structural member impact and *extremely unlikely* aircraft crash	Type B Shipping Container Design
SPILL-3-C [aircraft crash], PUNCT-3-C [aircraft crash], CRIT-4-C [aircraft crash]	POC	A3/F7 - *unlikely* to be breached by structural member impact and *extremely unlikely* aircraft crash	POC Design
SPILL-4 [heavy rain], SPILL-8 [heavy rain], SPILL-4 [flooding], SPILL-8 [flooding], SPILL-4 [freezing], SPILL-8 [freezing]	waste container	A17 - flooding events cannot lead to the toppling of a stack of waste containers	No control, basic assumption
FEXPLO-1 [aircraft crash], FEXPLO-2 [aircraft crash], CRIT-5 [aircraft crash]	any	A15 - aircraft crash cannot lead to a facility explosion event involving natural gas or propane	No control, basic assumption
FEXPLO-1 [high wind], FEXPLO-2 [high wind], CRIT-5 [high wind], FEXPLO-1 [tornado], FEXPLO-2 [tornado], CRIT-5 [tornado]	any	A16 - high winds or tornadoes cannot lead to a facility explosion event involving natural gas or propane	No control, basic assumption

5. ACCIDENT ANALYSIS

The accident analysis process examines each of the bounding accident scenarios defined in Section 4 3 6, *Bounding Scenario Selection* The examination and analysis performs multiple functions including (1) determination of any potential analysis variations for each accident scenario (*e g*, a fire scenario can occur in an area supported by fire suppression and can occur in an area with no automatic fire suppression capability), (2) refinement of accident scenario progression, (3) refinement of accident scenario initial frequency bin assignment, (4) refinement of accident scenario initial consequence bin assignment, (5) determination of bounding accident scenario risk class, (6) identification of any additional protective features that could be credited to reduce the risk class associated with undesired, high risk, bounding accident scenarios, and (7) determination of the final prevented / mitigated accident scenario risk class

There are six general types of accident scenarios identified in the Safety Analysis hazard evaluation that can yield a radiological release (1) facility fire, (2) spill, (3) puncture, (4) container explosion, (5) facility explosion, and (6) criticality These six general types of scenarios may be initiated by internal, natural phenomena, and external events There may be multiple specific accident scenarios identified within each general type of accident scenario to cover variations in initiating events within a general scenario type and to cover variations in accident locations within the Building 991 Complex in the case of internal initiating events Natural phenomena and external event accident scenarios are analyzed in a global fashion and evaluate all potential types of accidents that can result from the external initiating event (*e g*, a seismic event may initiate facility fires, spills, punctures, facility explosions, and criticalities)

The identified accident scenarios may impact up to five types of radioactive material containers that are distinguished by the type of radioactive material that they contain, the quantity of radioactive material that they contain, and the resistance of the container to various accident scenarios The five containers defined for the Safety Analysis are (1) Type B shipping containers, (2) POCs, (3) metal TRU waste containers, drums or boxes, (4) metal LLW containers, drums or boxes, and (5) wooden LLW boxes/crates Radioactive material contained as contamination in filter plenums, in ducting, in various components, and on structures has been determined to represent a Standard Industrial Hazard due to negligible contamination levels (see the Contamination Hazard discussion Section 4 1 3, *Radioactive Materials (Hazard/Energy Source 4)*) and is not included in the accident analysis portion of the Safety Analysis

The identified accident scenarios may also impact non-radioactive, hazardous material containers Non-radioactive hazardous materials in the Building 991 Complex have been determined to represent a Standard Industrial Hazard due to relatively low quantities and/or toxicity (see Section 4 1 8, *Toxic, Hazardous, or Noxious Materials (Hazard/Energy Source 9)*) and are not included in the accident analysis portion of the Safety Analysis

For each scenario type/container type combination, the accident analysis investigates the consequences associated with the accident scenario for three receptors (1) the public, as represented by the MOI, (2) the CW, and (3) the IW The MOI and CW consequence evaluations are quantitative while the IW consequence evaluation is strictly qualitative

5 1 ACCIDENT SCENARIO DISCUSSIONS AND ACCIDENT SCENARIO SUMMARY TABLES

The purpose of the accident analysis portion of the Safety Analysis is to refine the assessment of the risk associated with facility operation and to determine the appropriate set of protective features or controls to ensure safe operation Risk assessment refinement can be accomplished by improving the understanding of accident scenario progression, by improving the quality of the estimate of the scenario frequency, and by improving the assessment of accident scenario dose consequences Appropriate control set determination can be accomplished by initially crediting a set of protective features/controls that are expected to be in place during operation, by assessing the acceptability of the scenario risk under the expected set of controls, and by identifying appropriate controls for scenario risk reduction in cases where the scenario risk is unacceptable Control appropriateness may be determined using multiple factors including (1) risk reduction benefit, (2) control cost, (3) degree of unacceptable risk, and (4) control impact on operations

The accident analysis sections that follow address each of the six general types of scenarios In addition, a section dealing with natural phenomena and external event accident analysis is provided following the internal event analyses The sections begin with a general discussion of the scenarios to be evaluated and cover the determination of any required variations within the general scenario class The sections continue with specific bounding accident scenario analyses

For each specific bounding accident scenario to be analyzed, an accident scenario discussion and corresponding summary table are developed The scenario discussion and summary table present information describing (1) the accident scenario sequence, (2) the assumptions made in the analysis of the scenario, (3) the frequency bin assignment for the accident scenario, potentially under multiple sets of credited protective features, (4) the dose consequence and/or consequence bin assignment for the scenario, potentially under multiple sets of credited protective features, (5) the corresponding scenario risk class for these situations, (6) the sets of credited and defense-in-depth protective features associated with scenario prevention and mitigation, and (7) the credited protective feature set adequacy and vulnerability The format for the scenario discussion and scenario summary table is presented in the following text

5 1 1 Accident Scenario Discussion Format

The accident scenario discussions for each scenario evaluated have a consistent format as described below

- ***Accident Scenario* Section** This section of the accident scenario discussion provides a description of the accident scenario being analyzed This description addresses potential mechanisms for accident initiation, the relationship of Building 991 Complex activities to the scenario, accident scenario progression, and some general information on accident modeling assumptions

- *Accident Frequency* **Section** This section of the accident scenario discussion addresses the scenario frequency bin determination Arguments are presented on the basis for any scenarios that have frequency bin assignments other than *anticipated* Any protective features credited in the scenario frequency determination are identified

- ***Material-At-Risk*** **Section** This section of the accident scenario discussion addresses the scenario MAR Assumptions dealing with damage ratios (DRs) and numbers of containers involved in the scenario are presented for each container type impacted by the scenario The basis for any DR values less than 100 % and any protective features credited in the MAR determination are identified

- ***Accident Consequence*** **Section** This section of the accident scenario discussion addresses the radiological dose consequences associated with the accident scenario Based on the scenario progression, credited protective features, and the scenario MAR, consequences for the CW and the MOI are calculated These analyses are performed using the methodology described in Section 3 2 1, *Radiological Risk* A discussion of the results of the dose calculations and the identification of any protective features credited in the scenario consequence determination are presented in the next sub-section In addition, a qualitative determination of IW consequences is presented along with the basis for the determination Some discussion dealing with the consequences for workers within the facility but located away from the accident may be presented The discussion also presents the accident scenario risk class for each receptor based on the scenario frequency bin and consequence bin assignments

- ***Control Set Adequacy/Vulnerability*** **Section** This section of the accident scenario discussion addresses the adequacy and vulnerability of the control set developed from the protective features credited for accident prevention and mitigation The discussions begin by providing arguments dealing with accident scenario analysis conservatism in those cases where the scenario risk class is high (*i e*, Risk Class I or Risk Class II) Conservatism may be introduced in the assessment of scenario frequency, in the determination of DR values and scenario MAR (*e g*, use of upper bound MAR limits rather than expected MAR), in the determination of scenario progression (*e g*, hot gases from fire migrate through facility rather than exit through contiguous windows or doors), or in the modeling assumptions (*e g*, non-lofted plume for a large fire)

  The control set adequacy and vulnerability discussions continue by addressing the impact of the failure of credited protective features The control set developed for each accident scenario includes preventive and mitigative protective features that are credited in the determination of scenario frequency, consequence, and risk class The credited protective features are carried forward into the control set defined by the TSRs In the case of hardware controls, the system category (SC) assignment (*i e*, SC 1, SC 2, or SC 3), which is related to a Safety Class and Safety Significant structure, system, and component (SSC) determination, reflects the quality associated

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with SSC part replacements and the level of review associated with SSC-related work packages The SC assignment is intended to ensure appropriate operational reliability commensurate with the SSC importance to safety

Although the active credited preventive and mitigative features may be assured of high operational reliability by the TSRs and the SC designation, the active features are still vulnerable to failure that may introduce new scenarios that warrant evaluation Therefore, supplementary evaluations of scenario frequencies and consequences are performed that include the failure of active hardware protective features and/or Administrative Controls in the accident scenario progression This control set vulnerability assessment (1) confirms the adequacy of the control set, (2) identifies additional required controls to reduce the failed protective feature scenario risk class, or (3) identifies additional risk dominant scenarios

For credible cases in which the failed protective feature scenario risk class is higher than Risk Class III, preferentially, risk reduction is addressed by the identification of additional controls or, alternatively, risk acceptability is addressed by the discussion of available defense-in-depth controls and analysis conservatism That is, when a high risk scenario results from consideration of credited protective feature failure, the analysis focuses on identifying appropriate protective features that can be credited to reduce the scenario risk class, particularly in the case where the high risk scenario is in the *unlikely* frequency bin If appropriate protective features cannot be identified, the analysis assesses the adequacy of available defense-in-depth protective features and identifies analysis conservatism as justification for acceptance of the scenario risk

If failure of a specific protective feature is included in the scenario frequency or severity determination (*e g*, a protective feature failure path in an event tree), then the failure of that protective feature is not considered in the control set adequacy/vulnerability assessment In the cases where an active protective feature is credited and successfully performs its function in the analyzed scenario, failure of the credited feature is qualitatively assessed to reduce the scenario frequency by one frequency bin (*e g*, from *unlikely* to *extremely unlikely*), in most cases Within the control set adequacy/vulnerability assessment, the failed protective feature scenario risk classes are generally determined based on failing credited features one at a time Multiple failures of active protective features are only considered when (1) the failure of the protective feature is qualitatively assessed to reduce the scenario frequency by only one order of magnitude (*e g*, some "active" Administrative Controls), or (2) the scenario frequency bin assignment is *anticipated* prior to consideration of the protective feature failure

5.1.2 Accident Scenario Summary Table Format

The accident scenario summary table for each scenario evaluated in a class of accidents is presented at the end of the general accident scenario class section (*e g*, the summary tables for

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the analyzed facility fire scenarios are located at the end of the section dealing with facility fires) The tables have a consistent format as described below

- ***Hazard* Field** This field describes the hazard(s) being evaluated References to the Hazard/Energy Source entries in Table 8 are made
- ***Accident Type* Field** This field defines the accident type being evaluated and the hazardous material form or container A brief description of the scenario progression is provided along with the analyzed effective MAR Additional information may also be included to indicate the size and location(s) of the accident
- ***Cause or Energy Source* Field** This field lists the initiator or combination of initiators of the accident References to the Hazard/Energy Source entries in Table 8 are made Since the accidents being analyzed are bounding scenarios, there could be multiple initiators causing the same basic accident (*e g*, Vehicles, Material Handling Equipment, Raised Loads on Forklifts, Stacked Waste Containers could all be spill initiators) Generally, the more bounding or generic an accident is, the more types of initiators can be identified Distinctions between accident causes (*i e*, hazardous situation that leads to the scenario, for example, Movement of Waste Containers in the Facility) versus energy sources (*i e*, hazard providing the energy to begin the accident sequence, for example, Vehicles, Material Handling Equipment) may be made, where practical
- ***Applicable Activity(ies)* Field** This field relates the accident scenario back to the Building 991 Complex activities that are being analyzed in Safety Analysis Activity acronyms, as defined in Table 5, are used Activity relationships to the analyzed scenarios are defined in Table 62 and Table 63 as part of the development of the accident scenarios Since the accidents being analyzed are bounding scenarios, there could be multiple and varied relationships (*e g*, direct interaction, indirect interaction) between the analyzed scenario and the activities Generally, the more bounding or generic an accident is, the more varied the relationships (*e g*, the same activity may lead to the scenario directly in some situations and indirectly in other situations and the likelihood of the activity interaction with the scenario may range from *anticipated* to *extremely unlikely*) Distinctions between the form of the activity interaction (*i e*, direct or indirect) and the likelihood of the activity interaction (*i e*, more likely or less likely) may be made, where practical
- ***Receptor* Column** This column lists the receptor for which the dose consequence results or consequence determinations displayed in the row are applicable Three receptors are considered in the accident analysis the MOI (representing the public), the CW, and the IW A separate row is needed for each of these receptors because they are evaluated separately Consequences for the MOI and the CW are generally presented as quantitative radiological doses in rem along with the corresponding consequence bin determination, but consequences for the immediate worker are only presented in the qualitative terms as a consequence bin assignment
- ***Scenario Frequency - Without Prevention & With Prevention* Columns** These columns present a conservative estimate of accident scenario frequency associated

with the crediting of potentially varying sets of preventive features Accident scenario frequencies are categorized into qualitative frequency bins as suggested by DOE-STD-3011-94 (Ref 4) and discussed in Section 3 2, *Risk Classification Methodology* The frequency bin assignment is often based on qualitative judgments but can be determined quantitatively in certain situations (*e g*, event tree development) The frequency section in the scenario discussion describes which inherent preventive features were specifically credited to arrive at the assigned frequency bin for the ***Without Prevention*** column entry These inherent protective features were identified in the discussions of bounding accident scenarios in Section 4 3 6, *Bounding Scenario Selection*, and were credited in the determination of the bounding accident scenario initial frequency bin assignment Inherent preventive features are included in the ***Protective Feature*** column of the accident scenario summary table and are highlighted as <u>underlined</u> text to distinguish the inherent protective features from credited preventive features identified as part of the scenario risk reduction process, the results of which are displayed in the ***With Prevention*** column

In assigning accident scenario frequencies for both the "without prevention" and the "with prevention" situations, the guidance presented below was generally used in the determination of the initial frequency bin assignment for bounding scenarios and may be used in the determination of scenario frequencies as additional preventive features are credited in the analysis Use of event trees to determine scenario frequencies presents more explicit frequency and probability information that may not be consistent with the guidance below Any departures from the guidance will be noted and justified in any frequency discussions The general guidance for scenario frequency bin determinations is as follows

- <u>Administrative Controls</u> In general, an Administrative Control may be used to reduce the scenario frequency by one order of magnitude (multiply by 10^{-1}) Two or more independent Administrative Controls can be combined for a frequency reduction of no more than two orders of magnitude (multiply by 10^{-2}) or one frequency bin Exceptions will be noted and justified
- <u>SC 1/2 SSC in TSRs</u> In general, a SC 1/2 SSC that is well maintained and monitored due to its inclusion in the TSRs may be used to reduce the scenario frequency by two orders of magnitude (multiply by 10^{-2}) or one frequency bin Exceptions will be noted and justified

- ***Scenario Consequence - Without Mitigation & With Mitigation* Columns** These columns present a conservative estimate of accident scenario consequence associated with the crediting of potentially varying sets of mitigative features Accident scenario consequences are categorized into qualitative consequence bins as suggested by DOE-STD-3011-94 (Ref 4) and discussed in Section 3 2 1, *Radiological Risk* The consequence bin assignment for the CW and MOI is based on a quantitative dose consequence value determined by conservatively estimating the radiological dose to the receptor that is then compared to the radiological dose consequence bin thresholds

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in Table 2 The consequence to the IW is determined qualitatively using the guidance in Table 2

Non-criticality radiological dose consequences for the CW and the MOI are determined using the formulation presented in Section 3 2 1, *Radiological Risk* For all accident scenarios not dealing with severe weather induced accidents (*e g*, high wind, tornado), a conservative atmospheric dispersion factor (*i e*, 95th percentile χ/Q value) is used in the calculation of CW and MOI radiological dose consequences for comparison to the dose thresholds in Table 2 The MAR section in the scenario discussion describes how the effective MAR was determined The effective MAR is an input to the dose consequence calculation and can affect the consequence bin determination The consequence section in the scenario discussion describes which inherent mitigative features, if any, were specifically credited to arrive at the assigned consequence bin for the ***Without Mitigation*** column entry Any inherent protective features were identified in the discussions of bounding accident scenarios in Section 4 3 6, *Bounding Scenario Selection*, and were credited in the determination of the bounding accident scenario initial consequence bin assignment. Inherent mitigative features are included in the ***Protective Feature*** column of the accident scenario summary table and are highlighted as underlined text to distinguish the inherent protective features from credited mitigative features identified as part of the scenario risk reduction process, the results of which are displayed in the ***With Prevention*** column

- ***Scenario Risk Class - Without Prevention / Mitigation & With Prevention / Mitigation* Columns** These columns present a determination of accident scenario risk class associated with the crediting of potentially varying sets of protective features The scenario risk class is determined by entering Table 1 with the scenario frequency and consequence bin assignments for a specific receptor, as discussed in Section 3 2, *Risk Classification Methodology* If the scenario risk class displayed in the ***With Prevention / Mitigation*** column is Risk Class I or Risk Class II for either the IW, CW or the MOI, then the scenario is considered a risk dominant accident scenario Risk dominant scenarios are further discussed in Section 6, *Risk Dominant Accident Scenarios*

- ***Protective Feature* Column** This column presents the preventive and mitigative protective features credited in the evaluation of or providing defense-in-depth for each accident scenario As noted in the ***Scenario Frequency*** and ***Scenario Consequence*** column discussions, protective features that are underlined were inherently credited in the initial frequency and consequence bin assignments for the scenario Protective features that are not underlined may be part of an additional set of features that were credited in the final frequency and consequence bin assignments for the scenario Alternatively, features that are not underlined may be a set of identified defense-in-depth protective features (see the entries in the ***Feature Type*** column for classification) The function performed by each of the protective features listed in the table is defined in the accident scenario discussion text

It should be noted that all accident scenarios inherently credit an integrated set of SMPs to provide an infrastructure for conduct of operations and for general implementation and maintenance of any specifically identified controls The set of protective features leading to specific elements of SMPs (*e g*, Hazard Controls in Table 56) will be captured in the SMPs discussed in Chapter 3, *Safety Management Programs*, of the FSAR

- ***Feature Type* Column** This column identifies whether the protective feature listed in the ***Protective Feature*** column of the table is considered a credited feature (indicated by the letter, "C") or a feature that is not directly credited in the scenario frequency or consequence bin determinations but serves as a defense-in-depth feature (indicated by the letter, "D") A credited protective feature can be directly tied to a reduction in accident scenario frequency or consequences, even though the reduction may not be sufficient to change a frequency or consequence bin assignment A defense-in-depth protective feature cannot be related to the scenario frequency or consequence bin determinations but provides additional layers of defense for the protection of the public, CW, or IW The defense-in-depth features are identified in the accident scenario control set adequacy and vulnerability discussions
- ***Feature Purpose* Column** This column identifies whether the protective feature listed in the ***Protective Feature*** column of the table performs a preventive function that may be credited in scenario frequency reduction (indicated by the letter, "P"), performs a mitigative function that may be credited in scenario consequence reduction (indicated by the letter, "M"), or performs a combination of prevention and mitigative functions (indicated by the letters, "P/M") An example of the latter situation is the fire suppression system that may prevent large fires while mitigating the consequence of the smaller, suppressed fire
- ***Reference to TSRs* Column** This column cross-references an identified protective feature to the corresponding Limiting Condition for Operation (LCO) or Administrative Operating Limit (AOL) in Appendix A, *Building 991 Facility Technical Safety Requirements*, of the FSAR This column also cross-references an identified element of a Safety Management Program (SMP) to the applicable SMP in Chapter 3 of the *Building 991 Complex FSAR*

5.2 MATERIAL FIRE SCENARIO ACCIDENT ANALYSES

Thıs sectıon deleted sınce ın the hazard evaluatıon process ıt was assumed that pyrophorıc materıals would not be brought ınto the facılıty and that SNM contaıners complıed wıth Type B shıppıng contaıner requırements and wıth the requırements of procedure 1-W89-HSP-31 11 (Ref 20) These assumptıons made materıal fires ın the Buıldıng 991 Complex *not credıble* events

Table 76 Deleted

Table 77 Deleted

Table 78 Deleted

5 3 FACILITY FIRE SCENARIO ACCIDENT ANALYSES

5.3.1 Facility Fire Scenario Development and Selection

Three bounding facility fire scenarios were identified in Section 4 3 6 2, *Bounding Facility Fire Scenarios Determination* The first, B-FFIRE-1, involves the *unlikely* impact of a facility fire on a waste storage area inventory of LLW and/or TRU waste containers The second, B-FFIRE-2, involves the *extremely unlikely* impact of a transport vehicle fire at the dock on a transport vehicle inventory of LLW and/or TRU waste containers The third, B-FFIRE-3, involves the *extremely unlikely* impact of a direct flame impingement torch fire on a single POC container Each of these bounding scenarios are further defined in the following discussions

5.3.1.1 Waste Container Storage Area Fire Scenario Development and Selection

The Building 991 Complex Fire Hazards Analysis (FHA) (Ref. 33) was reviewed to characterize fire hazards within the waste storage areas of the complex As indicated in the discussion dealing with Waste Containers (*Hazard/Energy Source 4B*) in Section 4 1 3, *Radioactive Materials (Hazard/Energy Source 4)*, numerous storage areas for waste containers exist within the complex The storage areas include (1) small rooms with relatively low ceilings (north waste storage areas), (2) large rooms with relatively high ceilings (south waste storage areas), and (3) outside storage areas (West Dock Canopy waste storage area) Some of the storage areas have automatic sprinkler systems and other storage areas only have fire detection capability by smoke detectors (only the Building 996 waste storage area) Building 991 also includes an Office Area that is contiguous to but separated from the waste storage areas The analysis of waste storage area fires potentially involves numerous individual evaluations dealing with the attributes of various waste storage areas Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

To begin the evaluation, an assessment of the impact of a fire on various waste containers is performed ***Type B shipping containers*** and ***POC containers*** are designed in a manner that precludes failure of the containers due to any expected storage area fires other than direct flame impingement torch fires (Feature F15 and Feature F16, respectively) Expected storage area fires are limited to solid combustible material fires Fires involving flammable liquids are not considered due to lack of flammable liquid sources near waste storage areas (*e g*, diesel fuel tanks located away from storage areas), due to a lack of need for large quantities of flammable liquids in a waste storage mission, and due to a ***combustible material control*** program that restricts the introduction of flammable liquids into waste storage areas without appropriate controls

Expected storage area fires are capable of impacting the radioactive material inventories of LLW and TRU waste containers (*i e*, metal boxes and drums) and can involve the container and its inventory in the case of wooden LLW crates The wooden LLW crates are combustible The analysis of fires involving wooden LLW crates assumes that ***fire retardant wooden LLW crates*** are used that will not self-propagate a fire but will burn when exposed to a fire

While the metal waste containers are not combustible, the combustible material contents of the containers may be impacted by fires outside the container resulting in pyrolysis of the container contents, failure of the metal container lid seal, and venting of pyrolytic gases containing radioactive material through the failed container seal For high temperature and fast burning fires (*e g*, fuel pool fires), the rate of pyrolytic gas generation and pressure increase in the container may exceed the rate at which the container can vent, resulting in a loss of the container lid and ejection of some of the container contents By restricting flammable liquids and other combustible materials with high heat release rates in the facility via the ***combustible material control*** program, fires with heat release rates sufficient to cause container lid loss are not expected

The Building 991 Complex FHA (Ref 33) indicates that the fuel loading and fire potential in the Building 991 Complex is generally low The office area contains the majority of the fuel loading and its fuel loading is considered to be low to moderate The fuel loading in the radioactive waste storage areas of the Building 991 Complex is also considered to be low Only metal pallets are used in the storage of metal radioactive waste containers When stacked, these pallets are separated from the drum lids below by plywood sheets The plywood sheets are combustible but are difficult to ignite Wooden pallets are present in the Building 991 Complex though These pallets are used during the receipt/shipment of empty drums and for operational purposes are only required to be in Room 170 (the west dock) It is estimated that up to five pallets may be in Room 170 during these receipt/shipment operations at any one time The wooden pallets are in Room 170 for very short periods of time and are immediately removed from the building and stored outside when their use is not required Wooden pallets are not normally present in other waste storage areas in the Building 991 Complex ***Wooden crates*** are prohibited from metal radioactive waste container storage areas of Building 991 Per the Building 991 Complex FHA (Ref 33) there are no other unique fire hazards in the Building 991 Complex

The wooden pallet combustible loading is considered representative of potential combustible loading during ***combustible material control*** compliant operations The wooden pallets must have at least a ***five foot separation*** from metal radioactive waste containers under the combustible control program A combustible material control failure would be the placement of wooden pallets within five feet of waste containers (single Administrative Control failure)

Per Fire Protection Engineering (FPE) a stack of three wooden pallets has a heat release rate of approximately 1 MW, a stack of five wooden pallets has a heat release rate of approximately 2 MW, and a stack of 10 wooden pallets has a heat release rate of approximately 3 MW For the Building 991 Complex it is estimated that the most likely sized fire in the waste storage areas would be a 1 MW fire due to a combustible material control failure but that these areas could also be exposed to a 2 MW fire Larger fires may be realized in the office area and in the wooden waste crate storage area under the West Dock Canopy Assuming that the wooden pallets represent a transient combustible load in the Building 991 Complex, an area approach can be used to conservatively estimate the number of waste containers impacted by a fire involving stacked wooden pallets placed up against metal radioactive waste containers Wooden pallets are approximately 4 ft wide by 4 ft long and 4 inches high A stack of three pallets is therefore

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approximately one foot high Metal waste drums are approximately 2 feet in diameter and 3 feet in height Three pallets stacked up against the metal drums would cover one full drum and one-half of two other drums A fire involving the three stacked pallets would not be expected to have direct flame impingement on the second tier of stacked drums assuming that the flame height is twice the height of the combustible load (i e , the flame height is two feet) Therefore, for a stack of three wooden pallets it is estimated that the fire would impact three drums A stack of five pallets, or an approximate 2 MW fire, is also possible in the Building 991 Complex A stack of five pallets is approximately 1 7 ft high Five pallets stacked up against stacked waste drums would cover one full drum and one-half of two other drums on the first tier A fire involving the five pallets could be expected to have direct flame impingement on three drums in the second tier of stacked drums assuming that the flame height is twice the height of the combustible load (i e , the flame height is approximately 3 3 ft high) Therefore, for a stack of five wooden pallets it is estimated that the fire would impact six drums Either a 1 MW or 2 MW fire is considered appropriate to analyze for the combustible loading present in the Building 991 Complex metal radioactive waste container storage areas

Table 79 Deleted

The impact of an ***automatic sprinkler system*** on fires is difficult to determine and is dependent on the fire heat release rate, the ceiling height of the room, and the actuation time of the sprinklers To begin, it must be determined what size fires are necessary to even actuate the sprinklers for various room ceiling heights since the Building 991 Complex waste storage areas have ceiling heights ranging from approximately 18 ft to almost 40 ft Table 80 presents the results from a grossly simplified fire analysis (Ref 34) showing the minimum heat release rate for a moderate rate fire required to actuate a sprinkler system for various ceiling heights This information is not intended to be exact but is intended to be an approximation of minimum fire sizes to actuate sprinklers

Table 80 Minimum Heat Release Rates to Actuate Sprinklers for Various Ceiling Heights

CEILING HEIGHT (feet)	TIME TO ACTUATION (seconds)	HEAT RELEASE RATE (BTU)	HEAT RELEASE RATE (kW)
10	109	131	138
20	193	743	784
30	279	2,046	2,200
40	370	4,200	4,400

Based on the information in Table 80, a 1 MW or 2 MW fire will actuate sprinklers in areas with 20 ft or less ceilings and neither fire will actuate sprinklers in areas with ceilings in excess of 30 ft Ceiling heights in the north waste storage areas of Building 991 are generally 18 ft or less The ceilings for the Room 134 and Room 170 waste storage areas are both between 25 ft and 30 ft The West Dock Canopy Area ceiling height is between 30 ft and 40 ft It is conservatively assumed that a 1 MW fire will actuate sprinklers in the north waste storage areas and a 2 MW fire will <u>not</u> actuate sprinklers in Room 134, Room 170, and the West Dock Canopy Area It is assumed that a four wooden crate (considered to be approximately a 4 MW fire) fire will actuate sprinklers in the West Dock Canopy Area Building 996, in the north waste storage area, does not have a fire suppression system but does have a ***smoke detection system*** Two-high stacking of waste containers in Building 996 is possible.

In the north waste storage areas, a fire about half the size of a 1 MW fire may actuate the sprinklers In lieu of detailed fire modeling of the situation, it is conservatively assumed that actuation of the sprinklers will only cool the top tier of drums in each of the cases discussed above but will not cool the lower tier(s) This would yield a 3 drum impact for a 1 MW fire and a 3 drum impact in cases of a 2 MW fire for areas where the automatic sprinkler system actuates Table 81 presents a summary of the number of drums assumed to be impacted by various fires for both unmitigated and mitigated (*i e*, ***automatic sprinkler system*** actuation) situations

Table 81 Number of Waste Drums Impacted for Various Situations

GENERAL WASTE STORAGE AREA	ESTIMATED FIRE SIZE	MITIGATED BY SPRINKLERS	NUMBER OF DRUMS IMPACTED BY FIRE
North Waste Storage Areas	1 MW	sprinklers fail	3
		sprinklers work	3
	2 MW	sprinklers fail	6
		sprinklers work	3
Building 996 Storage Area	1 MW	no sprinklers	3
	2 MW	no sprinklers	6
South Waste Storage Areas	1 MW	sprinklers not actuated	3
	2 MW	sprinklers not actuated	6

To continue the determination of waste storage area fire scenarios, fire initial locations will be examined From Table 81, it is apparent that distinctions must be made between fires in the various waste storage areas The areas considered for fire initiation and potential waste storage area impact are (1) the Building 991 Office Areas (potential for fire to propagate to Room 134), (2) the north waste storage areas excluding Building 996, (3) the south waste storage areas excluding the West Dock Canopy waste storage area, (4) the Building 996 waste storage area, and (5) the West Dock Canopy waste storage area (potentially used for storage of wooden

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LLW crates) Table 82 presents a summary of the attributes of each of these Building 991 Complex areas

Table 82 Building 991 Complex Areas for Fire Evaluations

AREA	CEILING HEIGHT	AUTOMATIC SPRINKLER SYSTEM	SMOKE DETECTION SYSTEM	PERMITTED WASTE CONTAINERS
Office Area	Low	Wet-Pipe	No	None
North Area	Low	Wet-Pipe	No	Metal containers
Building 996	Low	No	Yes	Metal containers
South Area	High	Wet-Pipe	No	Metal containers
Canopy Area	High	Dry-Pipe	No	Wooden crates

Figure 6 through Figure 16 present event trees determining the likelihood of and number of waste containers impacted by fires associated with each of the areas identified in Table 82. The key assumptions associated with each event tree are displayed at the bottom of the figures Likelihood determinations are based on engineering judgment and generally are based on order of magnitude estimates of the likelihood General/specific rules for likelihood determination include

- reliable and/or well maintained systems are assigned likelihood values of 0 99 for successful operation,
- less maintained systems are assigned likelihood values of 0 90 for successful operation,
- the successful response by a notified ***Fire Department*** is assigned a likelihood of 0 95,
- an Administrative Control successful implementation is assigned a likelihood of 0 90 in most cases,
- personnel successful discovery of a fire is based on area occupancy,
- trained or untrained personnel response to fires is assigned a likelihood of 0 20 (*i e*, likelihood based on personnel receiving no hands-on fire extinguisher use training but receiving some educational training during the General Employee Training), and

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- fire initiation likelihood (*i e*, likelihood of a fire at an ignition source, not likelihood of a fire impacting combustibles or waste containers) is assigned a value of 0 10/yr in most cases

Figure 6 and Figure 7 address fires in the Building 991 Office Area and indicate that the propagation of a major fire in the Office Area to waste storage areas is considered to be a *beyond extremely unlikely* event As shown on Figure 6, it is assumed that fires in the Office Area occur roughly 0 10 times per year due to the limited hot work performed in the Office Area and due to the ***restrictions on smoking*** in the building Currently the Office Area of Building 991 is occupied at all times but the analysis is performed assuming only a day shift operation for five days a week yielding about a 20% chance that personnel will be in the Office Area at the time the fire is initiated While personnel are not specifically trained on fire fighting, there is some instruction provided on the use of a ***fire extinguisher*** in the General Employee Training that is received by everyone on the Site It is assumed that there is a 20% chance that personnel in the Office Area at the time of the fire will act to extinguish the fire and that the fire is initially small enough for untrained personnel to extinguish (*e g*, waste basket fire, computer terminal fire) The ***fire extinguishers*** are considered to be well maintained components and are assumed to fail only 1% of the time This yields a frequency of Office Area fires that are not extinguished of 0 096/yr

Figure 7 carries this fire frequency forward and examines the likelihood that additional combustibles are located in the vicinity of the fire to allow for fire growth. Since combustibles in the Office Area are not strictly controlled, there is only a 10% chance that no additional combustibles will be present If combustibles are present, the fire is assumed to grow to a point where the ***automatic sprinkler system*** may be actuated This well maintained system is conservatively assumed to fail only 1% of the time Failure of the ***automatic sprinkler system*** is assumed to allow fire growth to involve the entire Office Area At this point in the scenario, windows on the south side of the building will probably have been breached and hot gases from the fire will most likely exit the facility through the windows and exterior doors There is a possibility that the hot gases may migrate back into the waste storage areas, particularly Room 134 even though the ventilation system flow is minimal in that direction ***Fire doors*** in the corridor between the Office Area and Room 134 serve to further reduce the likelihood that the hot gases will travel in that direction Since the corridor from the Office Area to the waste storage areas is primarily a personnel corridor rather than a materials entry and exit path, the ***fire doors*** are assumed to only be open 1% of the time in fire situations The ***fire doors*** are not equipped with automatic closure devices (e g , fusible links) The doors are normally only opened for personnel access to the waste storage areas of the building Heavy equipment traffic (e g , forklifts) are not required in this hallway There are no normal operational requirements to keep the ***fire doors*** in an open configuration If the ***fire doors*** are held open for some reason, there is still only a limited amount of hot gas migration expected into the waste storage areas If anything, the Room 170 and Room 134 path may serve to feed air to the fire while hot gases escape via the windows of the Office Area (*i e*, air will be drawn from the dock through Room 134 to feed the fire) A 10% chance is conservatively assigned for the likelihood of significant hot gases (sufficient to impact waste containers) migrating into the waste storage areas This yields an overall frequency of an Office Area fire that can impact waste storage areas of 8 64E-07/yr, a *not credible* or *beyond extremely unlikely event*

Figure 8 through Figure 11 address fires in the waste storage areas other than for Building 996 and the West Dock Canopy Areas As shown on Figure 8, it is assumed that fires in the waste storage areas that involve sufficient combustibles to impact waste containers (modeled as a 1 MW fire) occur roughly 0 01 times per year due to requirements for ***hot work permits***, a strict ***combustible material control*** program, and the lack of need for combustibles to be in the waste storage areas Part of the ***combustible material control*** is a prohibition on having ***wooden crates*** in the waste storage areas inside any facility and a requirement that combustible materials have at least a ***five foot separation*** from stored waste containers The waste storage areas are assumed to have personnel within the area about half the time during each day shift yielding about a 10% chance that personnel will be in the waste storage area at the time the fire is initiated This likelihood is intended to balance the likelihood of having a fire (*i e*, more likely when personnel are present conducting operations) with the likelihood of personnel being in the area Spontaneous combustion of combustibles or electrical system shorts leading to significant combustible material fires are not expected to be as likely as fires initiated following hot work While personnel are not specifically trained on fire fighting, there is some instruction provided on the use of a ***fire extinguisher*** in the General Employee Training that is received by everyone on the Site It is assumed that there is a 20% chance that personnel in the waste storage area at the time of the fire will act to extinguish the fire and that the fire is initially small enough for untrained personnel to extinguish (*e g*, rags at a job site) The ***fire extinguishers*** are considered to be well maintained components and are assumed to fail only 1% of the time This yields a frequency of waste storage area fires that are not extinguished of 9.8E-03/yr Distinctions between personnel knowing about the fire or not knowing are made for later evaluations The unawareness likelihood is found by dividing the 9 00E-03/yr frequency of a fire without personnel being aware by the total 9 80-03/yr frequency fires that are not extinguished

Figure 9 carries the 1 MW fire frequency forward and examines the likelihood that excessive combustibles (modeled as a 2 MW fire) are close enough to the fire to become involved and examines the likelihood that the combustible materials are within five feet of waste storage containers The "Personnel Aware Of Waste Storage Area Fire" split fraction (*i e*, second column of Figure 9) is found by determining what fraction of the fires from Figure 8 are associated with the path through the event tree For example, the personnel not aware value (lower path in Figure 9) is determined by dividing the "personnel unaware" result from Figure 8 (*i e*, 9 00E-03) by the total likelihood of the fire not being extinguished (*i e*, 9 802E-03) yielding a value of 0 9182, as shown on Figure 9 This split fraction approach is used in Figure 10 through Figure 14 and Figure 16

In Figure 9, the failure of the ***five foot separation*** control and the excessive combustible materials event are considered to be probabilistically independent events, even though they both fall under the ***combustible material control*** program, due to the nature of waste storage areas The lack of combustible materials needed for waste storage operations makes the occurrence of excessive combustible materials in a waste storage area very noticeable Based on treating these two events as independent and assigning an Administrative Control likelihood of failure of 10%,

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the frequency of 1 MW fires impacting waste containers in interior waste storage areas is about 8 82E-04/yr and the frequency of 2 MW fires impacting waste containers in interior waste storage areas is about 9 80E-05/yr These frequencies are determined by adding the known and unknown cases for the 1 MW and 2 MW fires

Figure 10 and Figure 11 present the same scenario development for a 1 MW fire and a 2 MW fire, respectively Distinction is raised between north waste storage areas with relatively low ceilings and south waste storage areas with relatively high ceilings in order to evaluate the benefit of various mitigative functions (see Table 81) In the north waste storage areas, the fire is assumed to grow to a point where the ***automatic sprinkler system*** may be actuated This well maintained system is conservatively assumed to fail only 1% of the time. The impact of the actuation of the ***automatic sprinkler system*** on the fire size and the number of waste containers impacted is defined in Table 81 and this information is carried forward in the scenario descriptive material in Figure 10 and Figure 11

Fire Department response is also considered in the scenario development and requires that personnel be aware of the fire to allow for notification of the ***Fire Department*** via ***fire phones*** The likelihood of successful ***Fire Department response*** is the combination of ***fire phone*** reliability (conservatively assumed to be 90% reliable due to the combination of a well maintained system, multiple phone locations, and personnel training) and ***Fire Department*** capability (capable of responding to fire within 15 minutes and mitigating the fire 95% of the time) A specific credit in fire size reduction is not defined for ***Fire Department response*** due to the difficulty in assessing fire growth rate versus response time

Based on the results of the waste storage area fire evaluations, the frequencies for various fire sizes in the waste storage areas are as follows

- 1 MW 3 drum fire in north storage area is an *unlikely* event (8 82E-04/yr),
- 1 MW 3 drum fire in south storage area is an *unlikely* event (8 82E-04/yr),
- 2 MW 3 drum fire in north storage area is an *extremely unlikely* event (9.70E-05/yr),
- 2 MW 3 drum fire in south storage area is *not credible* (no scenario identified),
- 2 MW 6 drum fire in north storage area is a *beyond extremely unlikely* event (9 80E-07/y), and
- 2 MW 6 drum fire in south storage area is an *extremely unlikely* event (9 80E-05/y)

Figure 8 and Figure 12 through Figure 14 address fires in the Building 996 waste storage area Figure 8 from the waste storage area fire evaluation is reused This yields a frequency of Building 996 waste storage area, 1 MW fires that are not extinguished of 9 8E-03/yr As before, distinctions between personnel knowing about the fire or not knowing are made for later evaluations

Figure 12 carries this 1 MW fire frequency forward and examines the likelihood that excessive combustibles (modeled as a 2 MW fire) are close enough to the fire to become involved and examines the likelihood that the combustible materials are within five feet of waste storage containers The failure of the ***five foot separation*** control and the excessive combustible materials event are considered to be probabilistically independent events, even though they both fall under the ***combustible material control*** program, due to the nature of waste storage areas The lack of combustible materials needed for waste storage operations makes the occurrence of excessive combustibles in a waste storage area very noticeable In addition, the Building 996 waste storage area is relatively small and the ability to place combustible materials in the area is questionable but is conservatively evaluated as a 1% chance of having the configuration Based on treating these two events (i e , five foot separation and excessive combustible materials) as independent and assigning an Administrative Control likelihood of failure of 10% to the proximity control, the frequency of 1 MW fires impacting waste containers in the Building 996 waste storage area is about 9 70E-04/yr and the frequency of 2 MW fires impacting waste containers in interior waste storage areas is about 9 80E-06/yr These frequencies are determined by adding the known and unknown cases for the 1 MW and 2 MW fires

Figure 13 and Figure 14 present the same scenario development for a 1 MW fire and a 2 MW fire, respectively Since there is no automatic sprinkler system in Building 996, fire mitigation by sprinklers is not possible ***Smoke detectors*** exist in the area and provide an opportunity for notification of the ***Fire Department*** in addition to personnel awareness and use of the ***fire phones*** The ***smoke detection system*** is considered to be a well maintained system and is conservatively assumed to fail only 1% of the time

Fire Department response is also considered in the scenario development A specific credit in fire size reduction is not defined for ***Fire Department response*** due to the difficulty in assessing fire growth rate versus response time Note that there is no difference in the number of containers involved in a Building 996 fire scenario as a result of mitigation Therefore, the protective features cited above and on Figure 13 and Figure 14 do not need to be credited as controls for fire mitigation but only serve a defense-in-depth function

Based on the results of the Building 996 waste storage area fire evaluations, the frequencies for various fire sizes are as follows

- 1 MW 3 drum fire in Building 996 is an *unlikely* event (9 70E-04/yr), and
- 2 MW 6 drum fire in Building 996 is an *extremely unlikely* event (9 80E-06/y)

Figure 15 and Figure 16 address fires in the West Dock Canopy waste storage area As shown on Figure 15, it is assumed that fires in the West Dock Canopy Area occur roughly 0 10 times per year due to the limited hot work performed in the West Dock Canopy Area The West Dock Canopy waste storage area is assumed to have personnel within the area about half the time during each day shift yielding about a 10% chance that personnel will be in the waste storage area at the time the fire is initiated This likelihood is intended to balance the likelihood of having a fire (*i e*, more likely when personnel are present conducting operations) with the likelihood of personnel being in the area Spontaneous combustion of combustibles or electrical system shorts leading to significant combustible material fires are not expected to be as likely as fires initiated following hot work While personnel are not specifically trained on fire fighting, there is some instruction provided on the use of a ***fire extinguisher*** in the General Employee Training that is received by everyone on the Site It is assumed that there is a 20% chance that personnel in the West Dock Canopy Area at the time of the fire will act to extinguish the fire and that the fire is initially small enough for untrained personnel to extinguish (*e g*, slow burning crates, small collections of trash) The ***fire extinguishers*** are considered to be well maintained components and are assumed to fail only 1% of the time This yields a frequency of West Dock Canopy Area fires that are not extinguished of 0 098/yr Distinctions between personnel knowing about the fire or not knowing are made for later evaluations The unawareness likelihood is found by dividing the 9 00E-02/yr frequency of a fire without personnel being aware by the total 9 80-02/yr frequency fires that are not extinguished

Figure 16 carries this West Dock Canopy Area fire frequency forward and examines the likelihood that the fire is within five feet of the wooden LLW crates and examines the effect of mitigation system responses on the number of LLW crates impacted by the fire Part of the ***combustible material control*** in the West Dock Canopy waste storage area is a prohibition in storing anything but ***LLW crates in the West Dock Canopy Area*** and a requirement that combustible materials have at least a ***fire foot separation*** from stored waste crates The combustible material separation from stored waste crates Administrative Control likelihood of failure is assigned a value of 10% If the fire involves the waste crates in the West Dock Canopy waste storage area, the fire is assumed to grow to a point where the ***automatic sprinkler system*** may be actuated This well maintained system is conservatively assumed to fail only 1% of the time As stated earlier, it is assumed that the actuation of the ***automatic sprinkler system*** could occur in response to a 4 wooden crate fire Due to the rate of fire growth associated with ***fire retardant wooden crates***, actuation of the ***automatic sprinkler system*** is assumed to stop fire propagation immediately (*i e*, limit fire to 4 wooden LLW crates)

Fire Department response is also considered in the scenario development and requires that personnel be aware of the fire to allow for notification of the ***Fire Department*** via ***fire phones*** The likelihood of successful ***Fire Department response*** is the combination of ***fire phone*** reliability (conservatively assumed to be 90% reliable due to the combination of a well maintained system, multiple phone locations, and personnel training) and ***Fire Department*** capability (capable of responding to fire within 15 minutes and mitigating the fire 95% of the time) Again, due to the rate of fire growth associated with the crate fire, the ***Fire Department response*** is credited with reducing the fire size to about half of the full inventory This is based on a requirement that ***a maximum of 50 LLW crates*** may be stored in the West Dock Canopy Area, an assumption that the entire fire duration would be about 30 minutes, and a response time of about 15 minutes

Based on the results of the West Dock Canopy waste storage area fire evaluations, the frequencies for various fire sizes in the waste storage area is as follows

- Medium 4 wooden LLW crate fire is an *unlikely* event (9 70E-03/yr),
- Large 30 wooden LLW crate fire is an *extremely unlikely* event (6 86E-06/yr), and
- Major 50 wooden LLW crate fire is an *extremely unlikely* event (9 12E-05/yr),

Initiating Event Fire Starts	Personnel Available	Personnel Trained	Fire Extinguisher Available	Likelihood Of Event (per year)	Remarks
Fire Starts 0 10	Yes 0 20	Yes 0 20	Yes 0 99	3 96E-03	Fire extinguished by personnel
			No 0 01	**4.00E-05**	**Fire not extinguished**
		No 0 80		**1.60E-02**	**Fire not extinguished**
	No 0 80			**8.00E-02**	**Fire not extinguished**

Assumptions

1 The Office Area is classified as an ordinary hazard occupancy,
2 Ignition sources and combustibles are present in the Office Area,
3 Personnel are located in the Office Areas approximately 40 hours/week performing operations or conducting tenant activities,
4 Personnel are given a 20% probability of noticing/discovering a fire in the Office Areas
(40 hours/week occupied / 168 hours/week * 100% = 23 8%, which is rounded down to 20%),
5 General Employee Training provides exposure to the use of fire extinguishers but personnel are not trained for fire fighting, and
6 ***Fire extinguishers*** are located throughout the complex and are maintained per NFPA standards

Figure 6 Likelihood of Office Area Fire Being Extinguished by Personnel in Office Area

Fire In Office Area Not Extinguished	Additional Combustible Materials Absent	Automatic Sprinkler System Functions	Fire Doors Closed	Hot Gases Remain Out Of Storage Area	Likelihood Of Event (per year)	Remarks
Office Area Fire 9 60E-02 (see Fig 6)	Yes 0 10				9 60E-03	Small fire not involving waste
	No 0 90	Yes 0 99			8 56E-02	Medium fire not involving waste
		No 0 01	Yes 0 99		8 56E-04	Major fire not involving waste
			No 0 01	Yes 0 90	7 78E-06	Major fire not involving waste
				No 0 10	8 64E-07 *Not Credible* *	Hot gases impact upper tiers of stacked waste drums in South waste storage areas

* *Not Credible* is the same as *Beyond Extremely Unlikely*

Assumptions

1 There is a 90% probability that additional combustible to allow fire growth are present in the Office Area,
2 An ***automatic wet-pipe sprinkler system*** is located in the Office Area and is maintained per NFPA standards,
3 ***Fire doors will be left closed*** between Office Area and waste storage areas per Fire Protection requirements,
4 Very limited exhaust ventilation system flow from Office Area to waste storage areas (minor driving force),
5 Hot gases from major fire are most likely to exit the facility through exterior doors and windows, and
6 Hot gases that enter waste storage areas will rise to ceiling and impact upper tiers of drums

Figure 7 Likelihood of Office Area Fire Impacting Containers in Waste Storage Areas

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Initiating Event Fire Starts	Personnel Available	Personnel Trained	Fire Extinguisher Available	Likelihood Of Event (per year)	Remarks
			Yes	1 98E-04	Fire extinguished by personnel
			0 99		
		Yes			
		0 20			
	Yes		No	**2.00E-06**	**Fire not extinguished; personnel aware**
Fire Involving Combustible Mat'l	0 10		0 01		
		No		**8.00E-04**	**Fire not extinguished; personnel aware**
0 01		0 80			
	No			**9.00E-03**	**Fire not extinguished; personnel unaware**
	0 90				

Assumptions

1 Waste container storage areas are classified as low hazard occupancies,
2 Ignition sources but ***limited combustibles*** are present in the waste storage areas,
3 Initiating event covers the likelihood of a 1 MW fire involving wooden pallets because no other combustibles of significance are expected,
4 Personnel are located in the waste storage areas approximately 20 hours/week performing operations or conducting tenant activities,
5 Personnel are given a 10% probability of noticing/discovering a fire in the waste storage areas (20 hours/week occupied / 168 hours/week * 100% = 11 9%, which is rounded down to 10%),
6 General Employee Training provides exposure to the use of fire extinguishers but personnel are not trained for fire fighting, and
7 ***Fire extinguishers*** are located throughout the complex and are maintained per NFPA standards

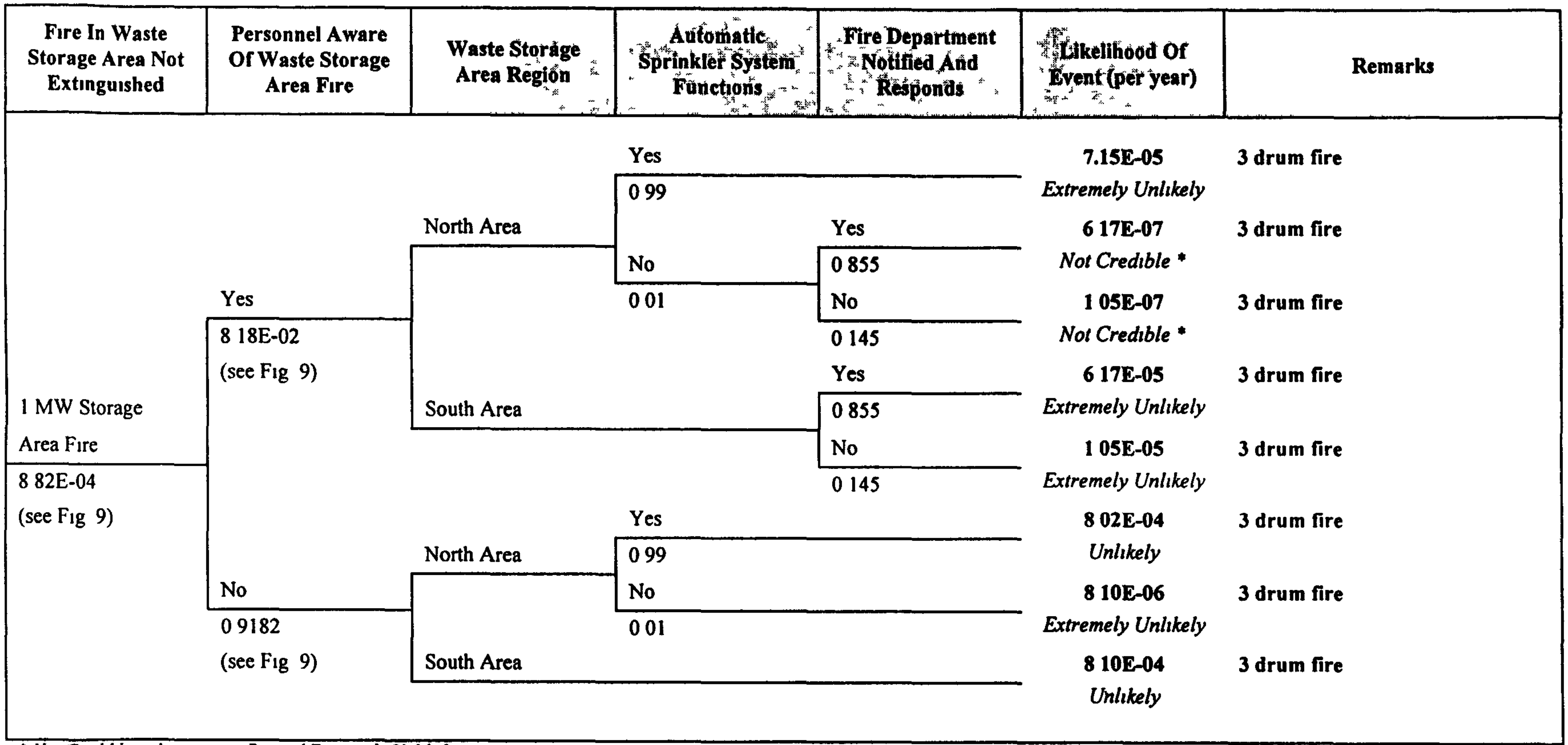
Figure 8 Likelihood of Waste Container Storage Area Fire Being Extinguished by Personnel

Fire In Waste Storage Area Not Extinguished	Personnel Aware Of Waste Storage Area Fire	Excessive Combustibles In Waste Storage Area	Combustibles Within Five Feet Of Containers	Likelihood Of Event (per year)	Remarks
Storage Area Fire 9 80E-03 (see Fig 8)	Yes 8 18E-02 (see Fig 8)	Yes 0 10	Yes 0 10	**8.02E-06**	**Known 2 MW fire**
			No 0 90	7 22E-05	2 MW fire not involving waste
		No 0 90	Yes 0 10	**7.22E-05**	**Known 1 MW fire**
			No 0 90	6 50E-04	1 MW fire not involving waste
	No 0 9182 (see Fig 8)	Yes 0 10	Yes 0 10	**9 00E-05**	**Unknown 2 MW fire**
			No 0 90	8 10E-04	2 MW fire not involving waste
		No 0 90	Yes 0 10	**8.10E-04**	**Unknown 1 MW fire**
			No 0 90	7 29E-03	1 MW fire not involving waste

Assumptions

1 The likelihood of a 1 MW fire in a waste storage area is included in initiating event likelihood,
2 A ***combustible material control*** failure must occur to have excessive combustibles (i e , a 2 MW fire) in the waste storage area, and
3 An independent ***combustible material control*** failure must occur to have combustible material within five feet of containers

Figure 9 Likelihood of Various Waste Container Storage Area Fires

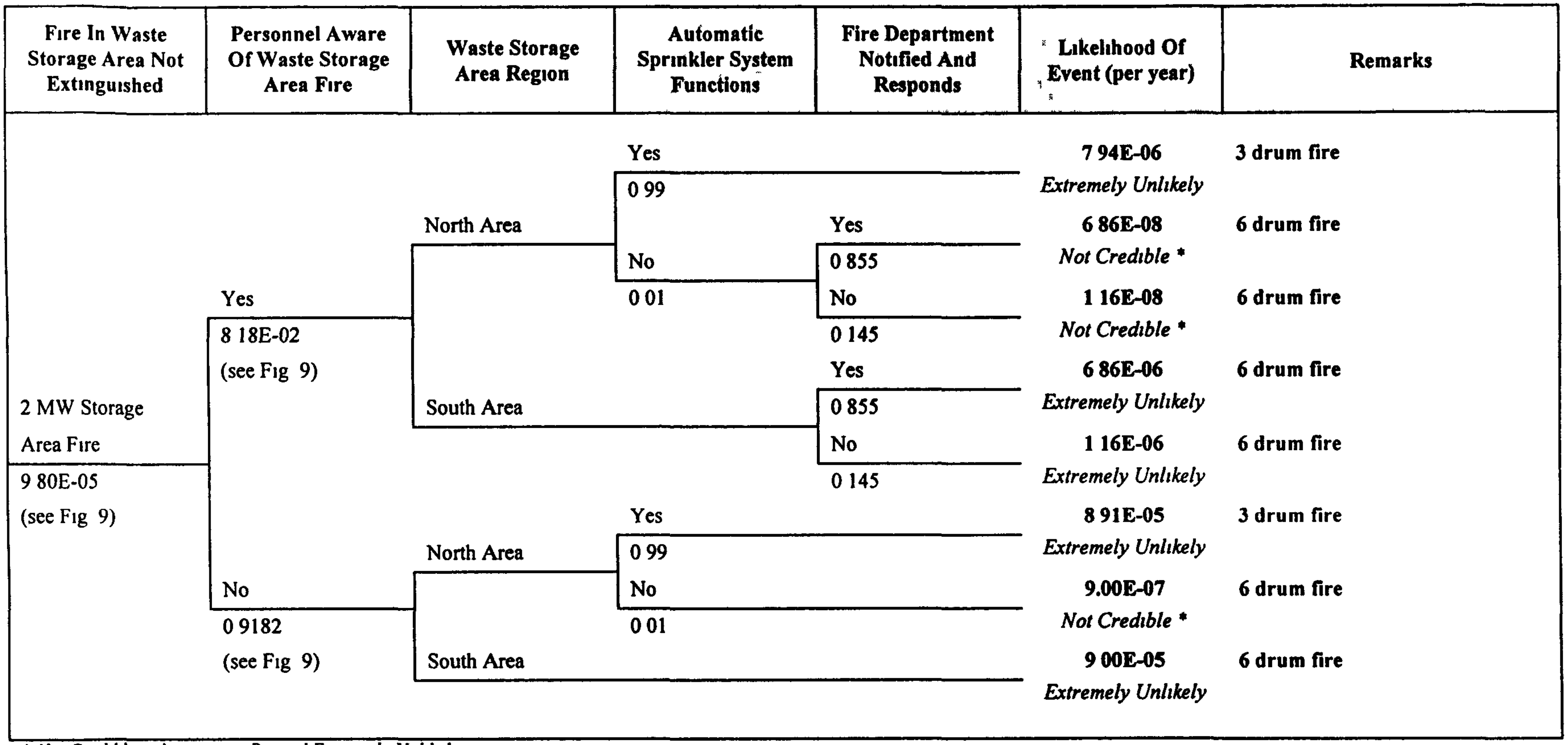


* *Not Credible* is the same as *Beyond Extremely Unlikely*

Assumptions

1 North waste storage areas have relatively low ceilings and the ***automatic sprinkler system*** can respond to a 1 MW fire,
2 South waste storage areas have relatively high ceilings and the ***automatic sprinkler system*** cannot respond to a 1 MW fire,
3 An ***automatic wet-pipe sprinkler system*** is located in all waste storage areas and is maintained per NFPA standards,
4 ***Fire phones*** are located throughout the complex and are maintained per NFPA standards (only 90% reliable), and
5 ***Fire Department response*** (95% reliable) requires ***fire phone*** use by aware personnel

Figure 10 Likelihood of a 1 MW Waste Container Storage Area Fire Impacting Containers in Waste Storage Areas



* *Not Credible* is the same as *Beyond Extremely Unlikely*

Assumptions

1 North waste storage areas have relatively low ceilings and the ***automatic sprinkler system*** can respond to a 2 MW fire,
2 South waste storage areas have relatively high ceilings and the ***automatic sprinkler system*** cannot respond to a 2 MW fire,
3 An ***automatic wet-pipe sprinkler system*** is located in all waste storage areas and is maintained per NFPA standards,
4 ***Fire phones*** are located throughout the complex and are maintained per NFPA standards (only 90% reliable), and
5 ***Fire Department response*** (95% reliable) requires ***fire phone*** use by aware personnel

Figure 11 Likelihood of a 2 MW Waste Container Storage Area Fire Impacting Containers in Waste Storage Areas

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Fire In Building 996 Not Extinguished	Personnel Aware Of Building 996 Fire	Excessive Combustibles In Building 996	Combustibles Within Five Feet Of Containers	Likelihood Of Event (per year)	Remarks
Building 996 Fire 9 80E-03 (see Fig 8)	Yes 8 18E-02 (see Fig 8)	Yes 0 01	Yes 0 10	**8 02E-07**	**Known 2 MW fire**
			No 0 90	7 22E-06	2 MW fire not involving waste
		No 0 99	Yes 0 10	**7.94E-05**	**Known 1 MW fire**
			No 0 90	7 15E-04	1 MW fire not involving waste
	No 0 9182 (see Fig 8)	Yes 0 01	Yes 0 10	**9 00E-06**	**Unknown 2 MW fire**
			No 0 90	8 10E-05	2 MW fire not involving waste
		No 0 99	Yes 0 10	**8 91E-04**	**Unknown 1 MW fire**
			No 0 90	8 02E-03	1 MW fire not involving waste

Assumptions

1 The likelihood of a 1 MW fire in Building 996 is included in initiating event likelihood,
2 Building 996 does not have large open areas to accommodate excessive combustible materials (representative of a 2 MW fire) in the waste storage area,
3 A ***combustible material control*** failure must occur to have a excessive combustible materials in Building 996, and
4 An independent ***combustible material control*** failure must occur to have combustible materials within five feet of containers

Figure 12 Likelihood of Building 996 Waste Storage Area Fires

Fire In Building 996 Not Extinguished	Personnel Aware Of Building 996 Fire	Fire Phone Functions	Building 996 Smoke Detection System Functions	Fire Department Notified And Responds	Likelihood Of Event (per year)	Remarks
Building 996 1 MW Fire 9 70E-04 (see Fig 12)	Yes 8 18E-02 (see Fig 12)	Yes 0 90	Yes 0 99	Yes 0 95	6.72E-05 *Extremely Unlikely*	3 drum fire
				No 0 05	3 54E-06 *Extremely Unlikely*	3 drum fire
			No 0 01	Yes 0 95	6 79E-07 *Not Credible* *	3 drum fire
				No 0 05	3 57E-08 *Not Credible* *	3 drum fire
		No 0 10	Yes 0 99	Yes 0 95	7 47E-06 *Extremely Unlikely*	3 drum fire
				No 0 05	3 93E-07 *Not Credible* *	3 drum fire
			No 0 01		7 94E-08 *Not Credible* *	3 drum fire
	No 0 9182 (see Fig 12)		Yes 0 99	Yes 0 95	8 38E-04 *Unlikely*	3 drum fire
				No 0 05	4.41E-05 *Extremely Unlikely*	3 drum fire
			No 0 01		8 91E-06 *Extremely Unlikely*	3 drum fire

* *Not Credible* is the same as *Beyond Extremely Unlikely*

Assumptions

1 Building 996 has no automatic sprinkler system but does have a ***smoke detection system*** maintained per NFPA standards,
2 Waste containers in Building 996 may be stacked 2-high,
3 ***Fire phones*** are located throughout the complex and are maintained per NFPA standards (only 90% reliable),
4 No credit is taken for the Site phone system to communicate with the Fire Department, and
5 ***Fire Department response*** (95% reliable) requires ***fire phone*** use by aware personnel or actuation of the ***smoke detection system***

Figure 13 Likelihood of Building 996 1 MW Fire Impacting Containers in Building 996

Fire In Building 996 Not Extinguished	Personnel Aware Of Building 996 Fire	Fire Phone Functions	Building 996 Smoke Detection System Functions	Fire Department Notified And Responds	Likelihood Of Event (per year)	Remarks
Building 996 2 MW Fire 9 80E-06 (see Fig 12)	Yes 8 18E-02 (see Fig 12)	Yes 0 90	Yes 0 99	Yes 0 95	**6 79E-07** *Not Credible* *	**6 drum fire**
				No 0 05	**3 57E-08** *Not Credible* *	**6 drum fire**
			No 0 01	Yes 0 95	**6 86E-09** *Not Credible* *	**6 drum fire**
				No 0 05	**3 61E-10** *Not Credible* *	**6 drum fire**
		No 0 10	Yes 0 99	Yes 0 95	**7 54E-08** *Not Credible* *	**6 drum fire**
				No 0 05	**3 97E-09** *Not Credible* *	**6 drum fire**
			No 0 01		**8 02E-10** *Not Credible* *	**6 drum fire**
	No 0 9182 (see Fig 12)		Yes 0 99	Yes 0 95	**8 46E-06** *Extremely Unlikely*	**6 drum fire**
				No 0 05	**4 46E-07** *Not Credible* *	**6 drum fire**
			No 0 01		**9 00E-08** *Not Credible* *	**6 drum fire**

* *Not Credible* is the same as *Beyond Extremely Unlikely*

Assumptions

1 Building 996 has no automatic sprinkler system but does have a ***smoke detection system*** maintained per NFPA standards,
2 Waste containers in Building 996 may be stacked 2-high,
3 ***Fire phones*** are located throughout the complex and are maintained per NFPA standards (only 90% reliable),
4 No credit is taken for the Site phone system to communicate with the Fire Department, and
5 ***Fire Department response*** (95% reliable) requires ***fire phone*** use by aware personnel or actuation of the ***smoke detection system***

Figure 14 Likelihood of Building 996 2 MW Fire Impacting Containers in Building 996

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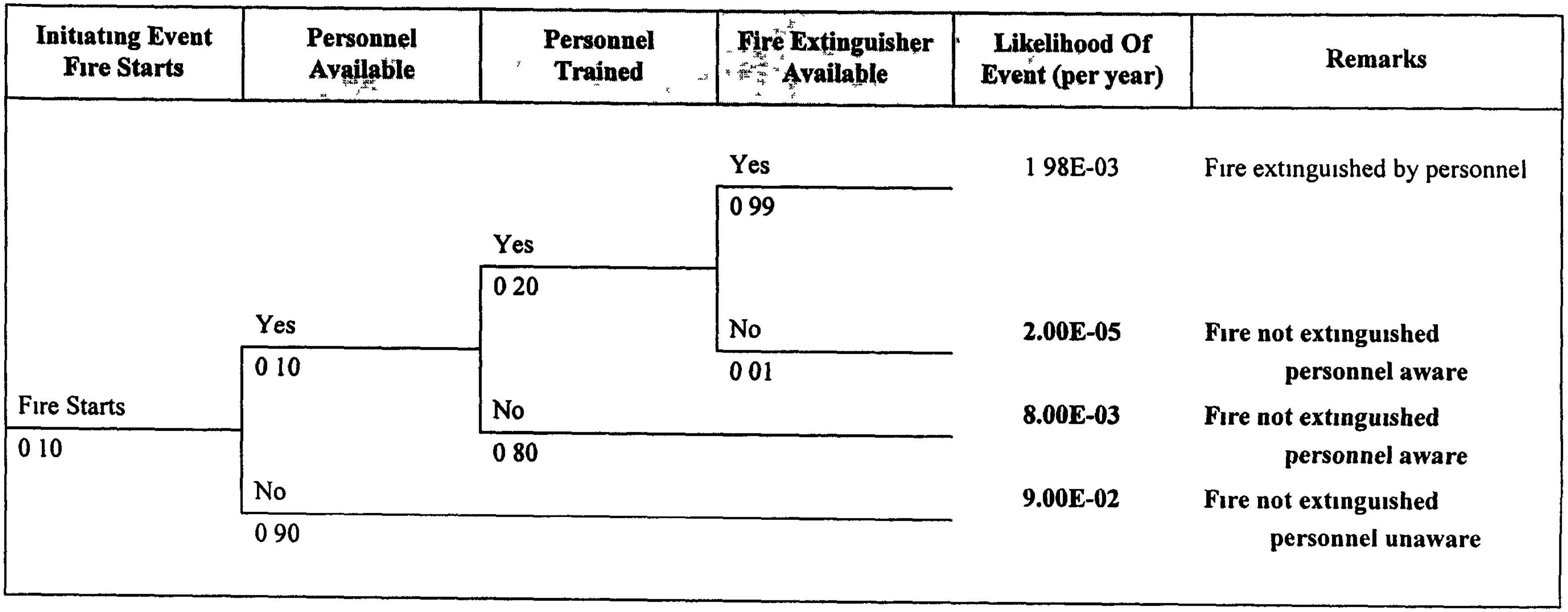
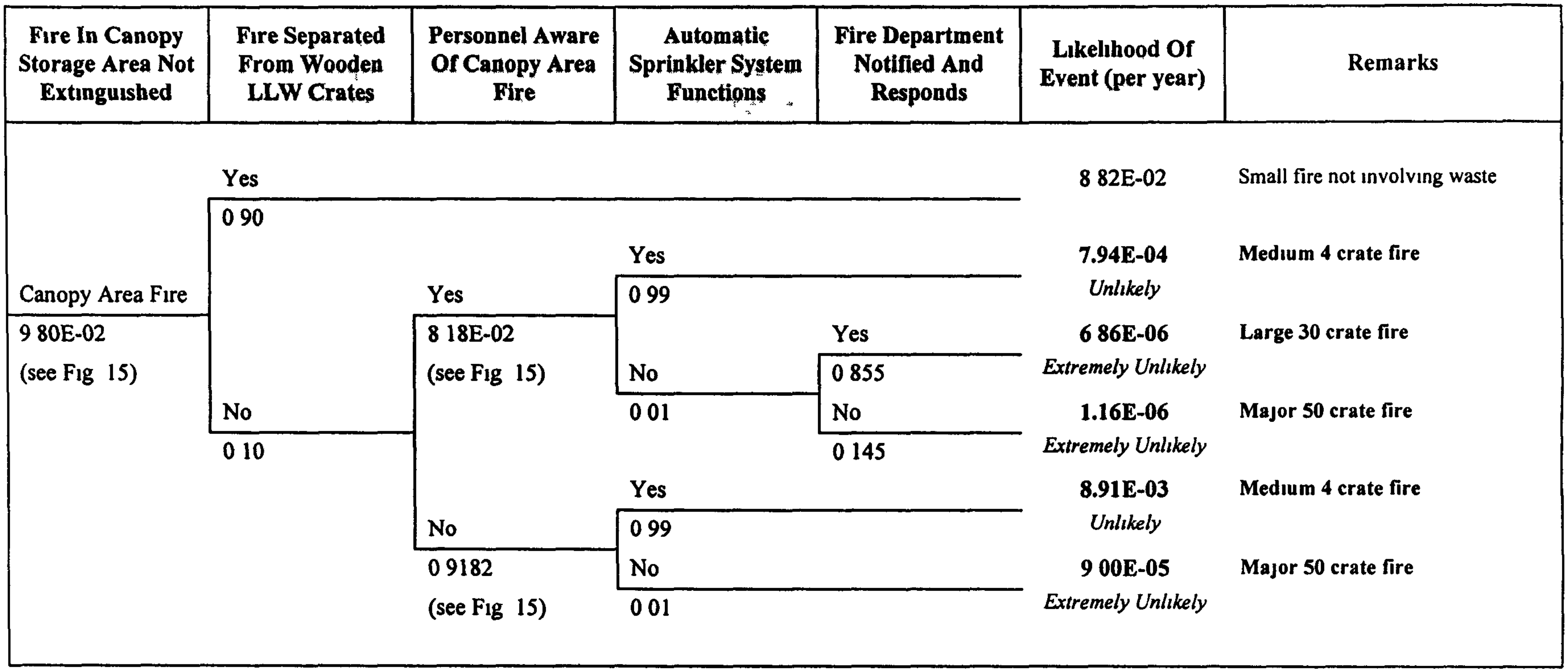


Assumptions

1 Ignition sources and combustibles are present in the Canopy waste storage area,
2 Personnel are located in the Canopy waste storage area approximately 20 hours/week performing operations or conducting tenant activities,
3 Personnel are given a 10% probability of noticing/discovering a fire in the Canopy waste storage area (20 hours/week occupied / 168 hours/week * 100% = 11 9%, which is rounded down to 10%),
4 General Employee Training provides exposure to the use of fire extinguishers but personnel are not trained for fire fighting, and
5 ***Fire extinguishers*** are located throughout the complex and are maintained per NFPA standards

Figure 15 Likelihood of Canopy Waste Storage Area Fire Being Extinguished by Personnel



Assumptions

1 A ***combustible material control*** failure must occur to have combustibles within five feet of wooden waste crates,
2 The Canopy Area has a relatively high ceiling and the ***automatic sprinkler system*** can respond to a four wooden waste crate fire,
3 An ***automatic dry-pipe sprinkler system*** is located in the Canopy waste storage area and is maintained per NFPA standards,
4 ***Fire phones*** are located throughout the complex and are maintained per NFPA standards (only 90% reliable), and
5 ***Fire Department response*** (95% reliable) requires ***fire phone*** use by aware personnel

Figure 16 Likelihood of Canopy Area Fire Impacting Containers in Canopy Waste Storage Area

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Table 83 summarizes the results of the event tree evaluations of fires in various waste storage locations Based on scenario similarities, unique or enveloping scenarios can be identified for further evaluation Any enveloping scenarios must carry forward the protective features credited in the evaluations of the enveloped scenarios The "Remarks" column of Table 83 indicates the scenarios to be further evaluated, identifies the enveloped scenario linkages to enveloping scenarios, and defines why the enveloped scenarios can be enveloped

Table 83 Summary of Waste Storage Area Fire Evaluation Results

WASTE STORAGE AREA	WASTE CONTAINER FIRE SIZE	FREQUENCY	REMARKS
North Waste Storage Areas	**1 MW 3 TRU waste drums**	***Unlikely* (8 82E-04/yr)**	**Due to the similarity of frequencies in each of the waste storage areas, no one waste storage area is considered more likely than the others to realize a 1 MW fire**
South Waste Storage Areas	**1 MW 3 TRU waste drums**	***Unlikely* (8 82E-04/yr)**	
Building 996 Waste Storage Area	**1 MW 3 TRU waste drums**	***Unlikely* (9 70E-04/yr)**	
North Waste Storage Areas	2 MW 3 TRU waste drums	*Extremely Unlikely* (9 70E-05/yr)	Enveloped by South Waste Storage Area, 6 drums, lower MAR
North Waste Storage Areas	2 MW 6 TRU waste drums	*Beyond Extremely Unlikely* (9 80E-07/yr)	Enveloped by South Waste Storage Area, 6 drums, lower frequency
Building 996 Waste Storage Area	2 MW 6 TRU waste drums	*Extremely Unlikely* (9 80E-06/yr)	Enveloped by South Waste Storage Area, 6 drums, lower frequency
South Waste Storage Areas	**2 MW 6 TRU waste drums**	***Extremely Unlikely* (9.80E-05/yr)**	**Enveloping Scenario**
Canopy Waste Storage Area	**Medium to Large 4 LLW waste crates**	***Unlikely* (9 70E-03/yr)**	**Unique scenario**
Canopy Waste Storage Area	Large 30 LLW waste crates	*Extremely Unlikely* (6 86E-06/yr)	Enveloped by Canopy Waste Storage Area, 50 crates, lower MAR
Canopy Waste Storage Area	**Major 50 LLW waste crates**	***Extremely Unlikely* (9.12E-05/yr)**	**Enveloping scenario**

Therefore, the waste storage area facility fire scenarios to be analyzed are

Facility Fire Scenario 1 - 1 MW TRU Waste Drum Facility Fire This facility fire involves the contents of 3 TRU waste drums located in either the Building 996, north or south waste storage areas This scenario is assigned an *unlikely* frequency in each of the Building 991 Complex metal waste container storage areas The facility fire is assumed to pyrolize the combustible contents of the 3 drums (600 grams WG Pu equivalent potentially involved) and release the radioactive material through drum seals that fail due to the fire The facility fire is evaluated as occurring in Room 170 but could occur in the other portions of the south waste storage area, the north waste storage areas, or in the Building 996 waste storage area

Facility Fire Scenario 2 - 2 MW TRU Waste Drum Facility Fire This facility fire involves the contents of 6 TRU waste drums located in the south waste storage areas This scenario bounds or envelopes other facility fire scenarios due to the assignment of an *extremely unlikely* frequency (same size fire in north waste storage area is a *beyond extremely unlikely* event and same size fire in Building 996 waste storage area is an order of magnitude less likely to occur even though it's in the same frequency bin) or due to the number of containers involved in the fire (same size fire in north waste storage area has same frequency but involves fewer drums) The facility fire is assumed to pyrolize the combustible contents of the 6 drums (1,200 grams WG Pu equivalent potentially involved) and release the radioactive material through drum seals that fail due to the fire The facility fire is evaluated as occurring in Room 170 but could occur in the other portions of the south waste storage area, the north waste storage areas, or in the Building 996 waste storage area

Facility Fire Scenario 3 - Medium to Large Wooden LLW Crate Facility Fire This facility fire involves the contents of 4 wooden LLW crates located in the West Dock Canopy waste storage area This scenario does not bound or envelop any other facility fire scenarios and has an assignment of an *unlikely* frequency The facility fire is assumed to ignite the combustible contents of the 4 crates (12 grams WG Pu equivalent potentially involved) and directly release the radioactive material The facility fire is evaluated as occurring in the West Dock Canopy waste storage area

Facility Fire Scenario 4 - Major Wooden LLW Crate Facility Fire This facility fire involves the contents of 50 wooden LLW crates located in the West Dock Canopy waste storage area This scenario bounds another facility fire scenario due to the number of containers involved in the fire (smaller fire of same frequency in the West Dock Canopy waste storage area involves only 30 crates) and has an assignment of an *extremely unlikely* frequency The facility fire is assumed to ignite the combustible contents of the 50 crates (150 grams WG Pu equivalent potentially involved) and directly release the radioactive material The facility fire is evaluated as occurring in the West Dock Canopy waste storage area

5.3.1.2 Transport Vehicle Fire Scenario Development and Selection

The Building 991 Complex contains two dock areas where radioactive material containers (*Hazard/Energy Source 4A* and *Hazard/Energy Source 4B*) can be received or shipped On-site or off-site transport vehicles (*Hazard/Energy Source 5H*) are parked at the docks during the receipt and shipment activities The west dock area interfaces with Room 170 and is used for most of the receipt and shipment of radioactive material containers (*i e*, handles all Type B shipping containers and all waste containers except those stored in Room 166) This dock has a ramp interface that slopes away from the facility The east dock interfaces with an open dock area outside of Room 166 and will only handle waste containers to be stored in Room 166 The east dock also handles the non-radioactive material receipts and shipments for the facility This dock has no ramp interface with the facility (*i e*, the truck/trailer parking area is flat) The analysis of transport vehicle fires potentially involves numerous individual evaluations dealing with the attributes of various containers and the two docks Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

To begin the evaluation, an assessment of the impact of a fire on various waste containers is performed ***Type B shipping containers*** and ***POC containers*** are designed in a manner that precludes failure of the containers due to any expected external fires, including vehicle fires, other than direct flame impingement torch fires (Feature F15 and Feature F16, respectively) Expected vehicle fires are capable of impacting the radioactive material inventories of metal, LLW and TRU waste containers (*i e*, boxes and drums) and can involve the container and its inventory in the case of wooden LLW crates The wooden LLW crates are combustible Expected vehicle fires involve a flammable liquid source (*i e*, diesel fuel), but the containers are shielded from the pool fires by the bed of the trailer portions of the vehicle

Vehicle fires were evaluated in the *Salt Stabilization Program Transportation Risk* (Ref 35) report and in the *Evaluation of Risk Associated with Transportation Activities within the Protected Area* (Ref 36) The scenario evaluated addressed the possibility of a vehicle fire initiated by an electrical malfunction or short that results in a fire in the engine compartment The scenario assumed that the fire spreads through the fuel system or spreads via leaking fuel until it breaches the vehicle fuel tanks The fire scenario was postulated to occur regardless of whether the transfer vehicle is located at the dock or in transit This evaluation addresses the transport vehicle parked at the Building 991 docks

References 35 and 36 determined the likelihood of a transport vehicle fire, initiated by an electrical malfunction or short that results in a fire in the engine compartment, is a *Beyond Extremely Unlikely* event This frequency is based on (1) an initiation frequency for the electrical malfunction or short, (2) an exposure fraction for the time that radioactive materials of interest will be on the transport vehicle, (3) the likelihood that the fuel and the resulting fuel fire will center under the bed of the transport vehicle (accounts for crowning and slopes on the roads), and (4) the likelihood that a fuel fire located under the transport vehicle will breach the metal bed or enclosure of the transport vehicle and engulf containers on the transport vehicle

The only factor of concern in the above methodology for the Building 991 docks is the likelihood that the fuel and resulting fuel fire will center under the bed of the transport vehicle For the west dock, which has a distinct slope away from the building, the likelihood of the fuel pooling under the transport vehicle bed is reduced to 0 0 The east dock area has no noticeable slope so the likelihood of the fuel pooling under the transport vehicle is probably greater than 0 5 Unless it is assumed that the pooling of fuel under the transport vehicle bed occurs 100% of the time, the likelihood of this scenario remains as *Beyond Extremely Unlikely* The east dock is only used for shipping or receiving waste containers from Room 166 The west dock is used for all other receipts and shipments of waste containers Therefore, the amount of time that a transport vehicle will be at the east dock is further reduced Based on these factors it is estimated that the likelihood of a fire occurring at the east dock is a *Beyond Extremely Unlikely* event

Therefore, no credible facility fire scenarios are postulated dealing with a transport vehicle parked at the Building 991 docks

5.3.1.3 Direct Flame Impingement Torch Fire Scenario Development and Selection

The Building 991 Complex personnel may use propane or other flammable gas torches (*Hazard/Energy Source 5B*) in support of construction and maintenance activities This type of equipment has the potential to directly impact Type B shipping containers (*Hazard/Energy Source 4A*) or waste containers (*Hazard/Energy Source 4B*) located in the complex Type B shipping containers were eliminated from consideration due to Requirement R2 that ***restricts the use of propane or other flammable gases in vaults while SNM is present*** TRU waste or LLW container direct flame impingement torch fires were enveloped by other facility fires impacting the containers The only remaining container of interest in this scenario is the POC container

Requirement R3 requires that work controls be in place to ensure that waste container direct exposure to propane or other flammable gas flames is an *extremely unlikely* event This requirement should not be difficult to implement, in most cases, in that movement of the waste containers away from any areas where flammable gas is being used should satisfy the requirement It is postulated that a flammable gas device is being used in the same room that stores POC containers. The containers are separated from the work area per guidance by Fire Protection organizations It is possible that a worker fall off a ladder or suffer some ailment that results in the flammable gas device being dropped in the direction of the stored containers Portable propane gas cylinders may be able to roll toward waste containers Oxyacetylene torches are not likely to roll but could fall near waste containers

In the case of a POC container, a pipe component is located inside a 55-gallon drum Propane torches are most likely to come in contact with containers due to the possibility of their rolling when dropped However, propane torches are *unlikely* to breach even the outer container due to the relatively low temperature associated with the torch in combination with the significant heat sink available in the drum Subsequent breaching of the pipe component is considered to be *not credible* The combination of Requirement R3 and the *unlikely* breach of the container by a propane torch assumption leads to a *beyond extremely unlikely* event, which is not further evaluated

Oxyacetylene torches or other relatively high temperature torches would breach the outer container of a POC if they came in contact with the container For the torch flame to be aligned in a manner to breach the outer container and then act on the pipe component in a manner leading to breach of the pipe is considered to be an *unlikely* if not *extremely unlikely* event without intentional directing of the torch flame The combination of Requirement R3 and the *unlikely* to *extremely unlikely* breach of both the outer and inner containers by a high temperature torch assumption leads to a *beyond extremely unlikely* event, which is not further evaluated

Therefore, no credible facility fire scenarios are postulated dealing with direct flame impingement on waste containers by flammable gas torches

5.3.2 Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire

This accident scenario is discussed below and is summarized in Table 85 located at the end of Section 5 3, *Facility Fire Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

<u>Accident Scenario</u>

A facility fire is postulated to impact up to three 55-gallon waste containers (*Hazard/Energy Source 4B*) The facility fire may occur as a result of the presence of propane (*Hazard/Energy Source 5B*), natural gas (*Hazard/Energy Source 5C*), or other combustibles (*Hazard/Energy Source 13F*) being ignited during the conduct of hot work or by exposure to electrical system components (*Hazard/Energy Source 5E*) The facility fire may occur in Building 996, any north waste storage area, or any south waste storage area The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste containers The fire causes heating of the waste containers and their contents, pyrolyzing of the container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals A violent loss of the drum lid from overpressure of the container is not postulated to occur due to the relatively slow heating rate of a solid combustible material fire (versus a flammable liquid pool fire that can cause lid loss) and due to the relatively low heat flux and total heat energy associated with the limited amount of combustibles This assumption is supported due to the requirement of a ***combustible material control*** program that restricts flammable liquids and other combustible materials with high heat release rates from the facility or strictly controls the use of any such combustible material in the facility The combustible loading associated with the fire is modeled as three wooden pallets located within five feet of the impacted waste containers The fire may last for 30 minutes or more but is conservatively evaluated as a short duration fire (modeled as a 10 minute release) The fire is modeled as a confined material release due to the assumption that the fire only fails the container lid seals and does not lead to container lid loss Due to the amount of heat energy associated with this fire and the potential distance to the release from the facility through a ventilation system, a ground-level (non-lofted) release of the radioactive material is conservatively assumed

Scenario Modeling Assumptions fire, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The postulated accident scenario is considered to be an *unlikely* event The likelihood of this scenario was initially defined by conditions occurring in or requirements imposed on the facility

- Requirement R8 indicates that ***combustible material control*** and ***ignition source control*** programs must be implemented to make fires in areas containing staged, stored, or in-process radioactive materials *unlikely* events, and
- Feature F17 indicates that the breach of any ***flammable gas containers*** that are used in the performance of activities must be an *unlikely* event due to container resistance to impacts

The ***combustible material control*** and ***ignition source control*** programs, for example, include (1) restrictions on the introduction of flammable liquids or other high heat release rate combustibles into waste storage areas without appropriate controls, (2) requirement that ***no wooden crates*** are present in the waste storage areas (excludes the West Dock Canopy area), (3) placing ***restrictions on smoking*** in the facilities, and (4) requirements that ***hot work permits*** be developed for the conduct of any spark, heat, or flame producing work in the facility

Inherent in the likelihood determination for facility fires was the requirement that ***electrical systems are maintained*** in the Building 991 Complex (made to maintain assumptions about the likelihood of electrical power system (*Hazard/Energy Source 5E*) failures leading to fires are *unlikely* to *extremely unlikely* events)

In the event tree analysis for waste storage area fires, the following assumptions, features, and requirements were made to determine that the fire is an *unlikely* event

- Assumption personnel in waste storage areas about 20 hours/week,
- Assumption untrained personnel will extinguish small fires 20% of the time (personnel do not receive hands-on portable fire extinguisher use training but do receive educational orientation concerning fire extinguishers during the General Employee Training),
- Feature ***fire extinguishers*** must be located throughout the waste storage areas and must be well maintained,
- Requirement it is prohibited to have ***wooden crates*** in internal waste storage areas as part of the ***combustible material control*** program,
- Requirement transient combustibles must have a ***five foot separation*** from stored waste containers as part of the ***combustible material control*** program, and
- Feature waste storage areas, except for Building 996, must have an ***automatic sprinkler system*** that must be well maintained

Scenario Modeling Assumptions *unlikely* event

Material-At-Risk

Up to three 55-gallon drums containing TRU waste are involved in the 1 MW facility fire scenario It is assumed that there is one or more failures of the ***combustible material control*** program and that combustible materials are placed within five feet of a stack of TRU waste drums Up to three drums are exposed to an unmitigated (*i e*, no sprinkler system response) 1 MW fire or are exposed to a mitigated (*i e*, ***automatic sprinkler system*** response) fire (north waste storage area only) The combustible loading associated with the fire is not restricted to wooden pallets but the pallets are used as representative combustible loads Small quantities of flammable liquids (*e g*, paint cans) could also be a candidate for the initial fire but it is expected that other fires involving small quantities of flammable liquids would have less impact and lead to less container involvement Due to the requirements of the ***combustible material control*** program, no fire is postulated that could lead to container lid loss Inherent in the assumption that the scenario can be modeled as a confined material release is the resistance of the ***metal waste container*** to fires of this type Also, the ***metal waste container*** is credited to preclude fire propagation between waste containers Based on General Assumption G4, no more than 200 grams (WG Pu equivalent) of radioactive material will be in a TRU waste drum and this is imposed as a ***container radioactive material loading*** limitation A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y It is conservatively assumed that the entire container inventory of the three drums is involved in the accident scenario (*i e*, DR = 1)

Scenario Modeling Assumptions 3 drums, 600 grams, blended DCF, DR = 1

Accident Consequence

The radiological dose consequences of facility fires involving TRU waste containers were originally assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequence) Based on Table 2, the radiological dose consequences of unmitigated facility fires were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of a facility fire involving three 55-gallon TRU waste drums are *moderate* (0 26 rem) to the MOI and *high* (35 rem) to the CW The resulting risk class for the scenario is Risk Class II for the MOI (*unlikely* frequency, *moderate* consequence) and Risk Class I for the CW (*unlikely* frequency, *high* consequence)

The IW located in the vicinity of the crate fire could have been seriously burned as a result of the scenario but the IW would almost have to come into close proximity of the burning material to be seriously impacted The more likely mechanism for IW serious injury or death deals with exposure of the IW to smoke leading to asphyxiation or to noxious components of the smoke This scenario either occurs in low ceiling rooms with ***automatic sprinkler system*** response that would tend to mitigate any smoke related effects or in high ceiling rooms that would significantly delay IW smoke related impacts There is the potential for the IW to inhale

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radioactive material being carried in the effluent from the fire (0 3 grams) but the IW would have to remain in the vicinity of the fire or in the path of the effluent It would be relatively easy for the IW to vacate the area with minimum dose impact if the IW is not incapacitated The radiological dose consequences for the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated fires, due to (1) the moderate amount of radiological material that is released, (2) the indicators of a fire (*e g*, smoke, flames) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for the scenario is Risk Class III for the IW (*unlikely* frequency, *low* consequence)

The IW located in the facility but away from the accident will not be exposed to the facility fire (no burn potential) unless the IW evacuation path is through the accident area This latter concern is unlikely to be realized due to the layout of the facility with multiple exit paths from most areas A fire of this type is expected to have sufficient heat energy to set off the ***automatic sprinkler system*** in the north waste storage areas that would yield a ***water gong alarm*** to inform some complex personnel Personnel who become aware of the activation of the sprinkler system may make an announcement over the ***LS/DW system*** or may lift a ***fire phone*** and activate the facility ***fire alarm*** to inform other personnel in the complex who may not have heard the ***water gong alarm*** A fire of this type in Building 996 is expected to set off the ***smoke detectors*** that may result in the ***Fire Department*** becoming aware of the fire, informing the facility of the condition, and the facility management informing personnel in the complex via the ***LS/DW system*** or via a general ***fire alarm*** initiated by lifting a ***fire phone*** Any personnel who are aware of the event can utilize ***fire phones*** to result in a facility ***fire alarm*** leading to evacuation of any facility IW unaware of the event per the facility ***emergency plan*** The consequences for the initially unaware IW are qualitatively judged to be *low* due to (1) the moderate amount of radiological material that is released, (2) the potential fire detection/announcement devices (*e g*, ***water gong alarms, smoke detectors, fire phones***) that will provide signals to alarm functions, (3) the indicators of a fire (*e g*, ***fire alarms, LS/DW***) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the IW to evacuate No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

Six preventive features have been credited in the determination of the scenario frequency and five mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the Administrative Control to provide a ***combustible material control*** program [five foot separation between combustibles and waste containers and ensuring that combustible material quantities remain low] (all receptors),

2 the Administrative Control for ***flammable gas container*** specifications (all receptors),

3 the Administrative Control for ***fire extinguisher*** placement and maintenance (MOI and CW),

4 the Administrative Control to provide an ***ignition source control*** program [restrictions on smoking in the facility, hot work permits] (all receptors),

5 the Administrative Control for ***electrical system maintenance*** to maintain current fire frequency assumptions (all receptors), and

6 the hardware control for an ***automatic sprinkler system*** in all internal waste storage areas other than Building 996 (MOI and CW)

The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors),

2 the Administrative Control for ***metal waste container*** specifications (all receptors),

3 the Administrative Control to provide a ***combustible material control*** program [flammable liquid or high heat release rate material restrictions] (MOI and CW),

4 the hardware control for an ***automatic sprinkler system*** in all internal waste storage areas other than Building 996 (MOI and CW); and

5 the Administrative Control of an ***emergency plan*** (IW only)

Failures of the preventive features are already assessed in or bounded by the scenario frequency determination event tree process and will not be addressed further The ***automatic sprinkler system*** preventive feature is stated to be credited in the determination of scenario frequency but the frequency bin assignment for this scenario will not change if the system is not credited This is due to the use of the south waste storage areas, where the sprinkler system is not activated, as the bounding scenario North waste storage area fire frequency increases if the sprinkler system is not credited but not enough to change the *unlikely* frequency bin determination

Failures of the ***container radioactive material loading*** mitigative feature (higher MAR containers, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR. The dose consequence bin assignment is already *high* for the CW so MAR increases will increase dose consequences but no change in the scenario CW risk class will result It would take almost 19 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 26 rem to 5 rem) This equates to an average TRU drum inventory of over 3,800 grams in each of the three drums Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a factor of two or less do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is no change in scenario risk class due to failure of the ***container radioactive material loading*** mitigative feature

Failures of the ***metal waste container*** mitigative feature (potential lid loss or fire propagation between containers, one frequency bin reduction due to standardization of waste containers) would result in a higher release fraction and/or additional MAR The dose consequence bin assignment is already *high* for the CW, so release fraction or MAR increases will increase dose consequences, but there is a decrease in scenario frequency (due to protective feature failure) resulting in a scenario risk class of Risk Class II for the CW for the scenario involving a failure of the ***metal waste container*** mitigative feature It would take almost

19 times the intermediate source term to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 26 rem to 5 rem) Fire scenario lid loss release fractions are two orders of magnitude higher (assumption is that material is ejected and is modeled as an unconfined combustible material fire) than the confined material fire release fractions If the material is not ejected (*i e*, remains in the drum) the release fractions for drum lid loss are the same as for drum lid seal failure Therefore, a degradation of the metal waste container such combustible material fires other than pool fires result in container lid loss will change the MOI consequence bin assignment to ***high*** but with the decrease in the frequency bin assignment, the risk class remains Risk Class II for the MOI (*extremely unlikely* frequency, ***high*** consequence) If the metal waste container mitigative feature failure results in an increase in fire propagation, almost 19 times the number of containers would have to be involved to change the MOI consequence bin assignment This equates to almost 57 drums being involved in the scenario Fires this large would actuate the ***automatic sprinkler system*** in the south waste storage areas and are considered to be *beyond extremely unlikely* events More likely a few additional drums would be involved, which does not change the scenario consequence bin assignment for any receptor Therefore, for this situation, the risk class for the CW becomes Risk Class II (due to frequency reduction with already ***high*** consequence bin), the risk class for the MOI remains Risk Class II, and the risk class for the IW becomes Risk Class IV (due to frequency reduction and maintenance of the *low* consequence bin) due to failure of the ***metal waste container*** mitigative feature

Failures of the ***combustible material control*** mitigative feature dealing with introduction of high heat rate combustibles (potential lid loss, one frequency bin reduction due to lack of need for such materials) would result in a higher release fraction The failure of the ***combustible material control*** mitigative feature dealing with excessive combustible materials in the facility is already addressed in the scenario frequency determination event tree process The dose consequence bin assignment is already ***high*** for the CW, so release fraction increases will increase dose consequences, but there is a decrease in scenario frequency (due to protective feature failure) resulting in a scenario risk class of Risk Class II for the CW for the scenario involving a failure of the ***combustible material control*** mitigative feature. Fire scenario lid loss release fractions are two orders of magnitude higher than the confined material fire release fractions Therefore, pool fires resulting in container lid loss will change the MOI consequence bin assignment to ***high*** but with the decrease in the frequency bin assignment, the risk class remains Risk Class II for the MOI (*extremely unlikely* frequency, ***high*** consequence) Therefore, for this situation, the risk class for the CW becomes Risk Class II (due to frequency reduction with already ***high*** consequence bin), the risk class for the MOI remains Risk Class II, and the risk class for the IW becomes Risk Class IV (due to frequency reduction and maintenance of the *low* consequence bin) due to failure of the ***combustible material control*** mitigative feature

. The failure of the ***automatic sprinkler system*** mitigative feature is already addressed in the scenario frequency determination event tree process Failures of the ***emergency plan*** mitigative feature (inadequate plan, one frequency bin reduction due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials The IW scenario consequences may increase to *moderate* for this event resulting in a Risk Class III scenario for the IW due to the higher consequences associated with the longer

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duration exposure Therefore, for this situation, there is <u>no change in scenario risk class for the IW</u> due to failure of the ***emergency plan*** mitigative feature

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of incorrect introduction or placement of combustibles

- ***Flow Alarm/Fire Department Response*** (MOI and CW only) For fires in areas covered by the ***automatic sprinkler system, flow alarm*** transmittal to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** Sprinkler response will occur for facility fires in the north waste storage areas and may occur for facility fires in the south waste storage areas

- ***Smoke Detectors/Fire Department Response*** (MOI and CW only) For fires in areas covered by ***smoke detectors,*** fire alarm transmittal to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** Smoke detection capability will be able to detect facility fires in Building 996

- ***Fire Phones/Fire Department Response*** (MOI and CW only) ***Fire phone*** communication to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** There is a possibility that the fire will be noticed by personnel but the most likely scenario would not have personnel detection of the fire

- ***Filtered Exhaust Ventilation*** (MOI and CW only) For fires in ventilated areas (north waste storage areas), the ***filtered exhaust ventilation*** systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the CW and the MOI

- ***Training*** (IW only) The IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***Water Gong Alarm/Automatic Sprinklers*** (IW only) For fires in areas covered by the ***automatic sprinkler system, water gong alarm*** activation may reduce IW consequences by providing indication of a fire to some facility personnel Sprinkler response will occur for facility fires in the north waste storage areas and may occur for facility fires in the south waste storage areas

- ***Smoke Detectors/LS/DW*** (IW only) For fires in areas covered by ***smoke detectors,*** once informed by the ***Fire Department,*** facility management can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of a fire to facility personnel Smoke detection capability will be able to detect facility fires in Building 996

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- ***Fire Phones/Local Fire Alarm*** (IW only) ***Fire phone*** use activates ***local fire alarms*** and can reduce IW consequences by providing indication of a fire to facility personnel Facility management may be informed by various alarms or the ***Fire Department*** or personnel may be aware of the fire and use the ***fire phone***

In summary, the analyzed accident scenario yields Risk Class I results for the CW, Risk Class II results for the MOI, and Risk Class III results for the IW Failures of individual mitigative features concurrent with the accident do not increase the risk class of the scenario for any receptor For many cases, there is a risk class reduction for the CW from Risk Class I to Risk Class II and for the IW from Risk Class III to Risk Class IV associated with the concurrent failures scenario Failures of the high heat release rate ***combustible material control*** mitigative feature may yield MOI doses in excess of 5 rem

5.3.3 Facility Fire Scenario 2 – 2 MW TRU Waste Drum Facility Fire

This accident scenario is discussed below and is summarized in Table 86 located at the end of Section 5 3, *Facility Fire Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A facility fire is postulated to impact up to six 55-gallon waste containers (*Hazard/Energy Source 4B*) The facility fire may occur as a result of the presence of propane (*Hazard/Energy Source 5B*), natural gas (*Hazard/Energy Source 5C*), or other combustibles (*Hazard/Energy Source 13F*) being ignited during the conduct of hot work or by exposure to electrical system components (*Hazard/Energy Source 5E*) The facility fire may occur in the south waste storage area, north waste storage area, or the Building 996 waste storage area. The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste containers The fire causes heating of the waste containers and their contents, pyrolyzing of the container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals A violent loss of the drum lid from overpressure of the container is not postulated to occur due to the relatively slow heating rate of a solid combustible material fire (versus a flammable liquid pool fire that can cause lid loss) and due to the relatively low heat flux and total heat energy associated with the limited amount of combustibles This assumption is supported due to the requirement of a ***combustible material control*** program that restricts flammable liquids and other combustible materials with high heat release rates from the facility or strictly controls the use of any such combustible material in the facility The combustible loading associated with the fire is modeled as five stacked wooden pallets located within five feet of the impacted waste containers The fire may last for 30 minutes or more but is conservatively evaluated as a short duration fire (modeled as a 10 minute release) The fire is modeled as a confined material release due to the assumption that the fire only fails the container lid seals and does not lead to container lid loss Due to the amount of heat energy associated with this fire and the potential distance to the release from the facility through a ventilation system, a ground-level (non-lofted) release of the radioactive material is conservatively assumed

Scenario Modeling Assumptions   fire, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The postulated accident scenario is considered to be an *unlikely* event   The likelihood of this scenario was initially defined by conditions occurring in or requirements imposed on the facility

- Requirement R8 indicates that ***combustible material control*** and ***ignition source control*** programs must be implemented to make fires in areas containing staged, stored, or in-process radioactive materials *unlikely* events, and
- Feature F17 indicates that the breach of any ***flammable gas containers*** that are used in the performance of activities must be an *unlikely* event due to container resistance to impacts

The ***combustible material control*** and ***ignition source control*** programs, for example, include (1) restrictions on the introduction of flammable liquids or other high heat release rate combustibles into waste storage areas without appropriate controls, (2) requirement that no wooden crates are used in the metal container waste storage areas or the facility, (3) placing ***restrictions on smoking*** in the facilities, and (4) requirements that ***hot work permits*** be developed for the conduct of any spark, heat, or flame producing work in the facility

Inherent in the likelihood determination for facility fires was the requirement that ***electrical systems are maintained*** in the Building 991 Complex (made to maintain assumptions about the likelihood of electrical power system (*Hazard/Energy Source 5E*) failures leading to fires are *unlikely* to *extremely unlikely* events)

In the event tree analysis for waste storage area fires, the following assumptions, features, and requirements were made to determine that the fire is an *extremely unlikely* event

- Assumption   personnel in waste storage areas about 20 hours/week,
- Assumption   untrained personnel will extinguish small fires 20% of the time (personnel do not receive hands-on portable fire extinguisher use training but do receive educational orientation concerning fire extinguishers during the General Employee Training),
- Feature   ***fire extinguishers*** must be located throughout the waste storage areas and must be well maintained,
- Requirement   it is prohibited to have ***wooden crates*** in internal waste storage areas as part of the ***combustible material control*** program, and
- Requirement   transient combustibles must have a ***five foot separation*** from stored waste containers as part of the ***combustible material control*** program

Scenario Modeling Assumptions   *extremely unlikely* event

Material-At-Risk

Up to six 55-gallon drums containing TRU waste are involved in the large facility fire scenario It is assumed that there is two or more failures of the ***combustible material control*** program and five stacked wooden pallets (i e , a 2 MW fire) are placed within five feet of a stack of TRU waste drums Up to six drums are exposed to an unmitigated (*i e*, no sprinkler system response) 2 MW fire The combustible loading associated with the fire is not restricted to wooden pallets but the pallets are used as a representative combustible load Small quantities of flammable liquids (*e g*, paint cans) could also be a candidate for the initial fire but it is expected that other fires involving small quantities of flammable liquids would have less impact and lead to less container involvement Due to the requirements of the ***combustible material control*** program, no fire is postulated that could lead to container lid loss Inherent in the assumption that the scenario can be modeled as a confined material release is the resistance of the ***metal waste container*** to fires of this type Also, the ***metal waste container*** is credited to preclude fire propagation between waste containers Based on General Assumption G4, no more than 200 grams (WG Pu equivalent) of radioactive material will be in a TRU waste drum and this is imposed as a ***container radioactive material loading*** limitation A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y It is conservatively assumed that the entire container inventory of the six drums is involved in the accident scenario (*i e*, DR = 1)

Scenario Modeling Assumptions 6 drums, 1,200 grams, blended DCF, DR = 1

Accident Consequence

The radiological dose consequences of facility fires involving TRU waste containers were originally assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequence) Based on Table 2, the radiological dose consequences of unmitigated facility fires were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of a facility fire involving six 55-gallon TRU waste drums are *moderate* (0 52 rem) to the MOI and *high* (71 rem) to the CW The resulting risk class for the scenario is Risk Class III for the MOI (*extremely unlikely* frequency, *moderate* consequence) and Risk Class II for the CW (*extremely unlikely* frequency, *high* consequence)

The IW located in the vicinity of the 2 MW fire could have been seriously burned as a result of the scenario but the IW would almost have to come into close proximity of the burning material to be seriously impacted The more likely mechanism for IW serious injury or death deals with exposure of the IW to smoke leading to asphyxiation or to noxious components of the smoke This scenario either occurs in high ceiling rooms that would significantly delay IW smoke related impacts There is the potential for the IW to inhale radioactive material being carried in the effluent from the fire (0 6 grams) but the IW would have to remain in the vicinity

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of the fire or in the path of the effluent It would be relatively easy for the IW to vacate the area with minimum dose impact if the IW is not incapacitated The radiological dose consequences for the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated fires, due to (1) the moderate amount of radiological material that is released, (2) the indicators of a fire (*e g*, smoke, flames) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for the scenario is Risk Class IV for the IW (*extremely unlikely* frequency, *low* consequence)

The IW located in the facility but away from the accident will not be exposed to the facility fire (no burn potential) unless the IW evacuation path is through the accident area This latter concern is unlikely to be realized due to the layout of the facility with multiple exit paths from most areas A fire of this type is not expected to have sufficient heat energy to set off the automatic fire suppression system in the south waste storage areas so no flow-related fire alarm will occur Any personnel who become aware of the fire due to direct observation of smoke or flames can utilize ***fire phones*** to result in a facility ***fire alarm*** leading to evacuation of any facility IW unaware of the event per the facility ***emergency plan*** The consequences for the initially unaware IW are qualitatively judged to be *moderate* due to (1) the moderate amount of radiological material that is released, (2) the limited potential of fire detection/announcement devices (*e g*, ***fire phones***) that will provide signals to alarm functions, (3) the limited potential for indicators of a fire (*e g*, ***fire alarms***) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the fire-aware IW to evacuate No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

Five preventive features have been credited in the determination of the scenario frequency and four mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the Administrative Control to provide a ***combustible material control*** program [ensuring excessive combustible materials are not in the waste storage areas, five foot separation between combustibles and waste containers] (all receptors),

2 the Administrative Control for ***flammable gas container*** specifications (all receptors),

3 the Administrative Control for ***fire extinguisher*** placement and maintenance (MOI and CW),

4 the Administrative Control to provide an ***ignition source control*** program [restrictions on smoking in the facility, hot work permits] (all receptors), and

5 the Administrative Control for ***electrical system maintenance*** to maintain current fire frequency assumptions (all receptors)

The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors),

2 the Administrative Control for ***metal waste container*** specifications (all receptors),

3 the Administrative Control to provide a ***combustible material control*** program [flammable liquid or high heat release rate material restrictions] (MOI and CW), and

4 the Administrative Control of an ***emergency plan*** (IW only)

Failures of the preventive features are already assessed in or bounded by the scenario frequency determination event tree process and will not be addressed further

Failures of the ***container radioactive material loading*** mitigative feature (higher MAR containers, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR The dose consequence bin assignment is already *high* for the CW so MAR increases will increase dose consequences but no change in the scenario CW risk class will result It would take almost 10 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0.52 rem to 5 rem) This equates to an average TRU drum inventory of over 2,000 grams in each of the six drums Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a factor of two or less do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is no change in scenario risk class due to failure of the ***container radioactive material loading*** mitigative feature

Failures of the ***metal waste container*** mitigative feature (potential lid loss or fire propagation between containers, one frequency bin reduction due to standardization of waste containers) would result in a higher release fraction and/or additional MAR Since the scenario was determined to be an *extremely unlikely* event, failure of the ***metal waste container*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***combustible material control*** mitigative feature dealing with introduction of high heat rate combustibles (potential lid loss, one frequency bin reduction due to lack of need for such materials) would result in a higher release fraction Since the scenario was determined to be an *extremely unlikely* event, failure of the ***combustible material control*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***emergency plan*** mitigative feature (inadequate plan, one frequency bin reduction due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials Since the scenario was determined to be an *extremely unlikely* event, failure of the ***emergency plan*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of incorrect introduction or placement of combustibles

- ***Automatic Sprinkler System*** (MOI and CW only) For fires in areas covered by the ***automatic sprinkler system***, actuation of the system can lead to scenario mitigation Sprinkler response may occur for facility fires in the south waste storage areas

- ***Flow Alarm/Fire Department Response*** (MOI and CW only) For fires in areas covered by the ***automatic sprinkler system, flow alarm*** transmittal to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** Sprinkler response may occur for facility fires in the south waste storage areas

- ***Smoke Detectors/Fire Department Response*** (MOI and CW only) For fires in areas covered by ***smoke detectors***, fire alarm transmittal to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** Smoke detection capability will be able to detect facility fires in Building 996

- ***Fire Phones/Fire Department Response*** (MOI and CW only) ***Fire phone*** communication to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** There is a possibility that the fire will be noticed by personnel but the most likely scenario would not have personnel detection of the fire

- ***Training*** (IW only) The IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***Water Gong Alarm/Automatic Sprinklers*** (IW only) For fires in areas covered by the ***automatic sprinkler system, water gong alarm*** activation may reduce IW consequences by providing indication of a fire to some facility personnel Sprinkler response may occur for facility fires in the south waste storage areas

- ***Fire Phones/Local Fire Alarm*** (IW only) ***Fire phone*** use activates ***local fire alarms*** and can reduce IW consequences by providing indication of a fire to facility personnel Facility management may be informed by various alarms or the ***Fire Department*** or personnel may be aware of the fire and use the ***fire phone***

In order to assure protection of the MOI and the CW against fires that are larger than the analyzed six TRU waste drum fire, several of the defense-in-depth features listed above will be credited (*i e*, no longer only serve as defense-in-depth features) for consequence mitigation of larger fires Specifically, the ***automatic sprinkler system***, the ***flow alarm/Fire Department response***, and, for protection against larger fires in the Building 996 storage areas, the ***smoke***

3 grams (WG Pu equivalent) of radioactive material will be in a wooden LLW crate and this is imposed as a ***container radioactive material loading*** limitation A blended DCF of 3 07E+07 is used to conservatively account for the population mix of wooden waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y It is conservatively assumed that the entire container inventory of the four crates is involved in the accident scenario (*i e*, DR = 1)

Scenario Modeling Assumptions 4 crates, 12 grams, blended DCF, DR = 1

Accident Consequence

The radiological dose consequences of facility fires involving LLW containers were originally assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequence) Based on Table 2, the radiological dose consequences of unmitigated facility fires were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of a facility fire involving four wooden LLW crates are *low* (0 0048 rem) to the MOI and *moderate* (0 66 rem) to the CW The resulting risk class for the scenario is Risk Class III for the MOI (*unlikely* frequency, *low* consequence) and Risk Class II for the CW (*unlikely* frequency, *moderate* consequence)

The IW located in the vicinity of the crate fire could have been seriously burned as a result of the scenario but the IW would almost have to come into close proximity of the burning material to be seriously impacted The more likely mechanism for IW serious injury or death deals with exposure of the IW to smoke leading to asphyxiation or to noxious components of the smoke This scenario occurs in high ceiling areas outside the facilities that would significantly delay IW smoke related impacts There is the potential for the IW to inhale radioactive material being carried in the effluent from the fire (0 006 grams) but the IW would have to remain in the vicinity of the fire or in the path of the effluent It would be relatively easy for the IW to vacate the area with minimum dose impact if the IW is not incapacitated The radiological dose consequences for the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated fires, due to (1) the low amount of radiological material that is released, (2) the indicators of a fire (*e g*, smoke, flames) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for the scenario is Risk Class III for the IW (*unlikely* frequency, *low* consequence)

The IW located in the facility but away from the accident will not be exposed to the facility fire (no burn potential) unless the IW evacuation path is through the accident area This latter concern is unlikely to be realized due to the layout of the facility with multiple exit paths from most areas A fire of this type is assumed to have sufficient heat energy to set off the ***automatic sprinkler system*** in the West Dock Canopy waste storage area that would yield a ***water gong alarm*** to inform some complex personnel Personnel who become aware of the activation of the sprinkler system may make an announcement over the ***LS/DW system*** or may utilize ***fire phones*** to result in a facility ***fire alarm*** leading to evacuation of any facility IW unaware of the event per the facility ***emergency plan*** The consequences for the initially unaware IW are qualitatively judged to be *low* due to (1) the low amount of radiological material that is released, (2) the potential fire detection/announcement devices (*e g* , ***water gong alarms, fire phones***) that will provide signals to alarm functions, (3) the indicators of a fire (*e g* , ***fire alarms, LS/DW***) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the IW to evacuate No risk class designation for the initially unaware IW is provided

<u>Control Set Adequacy/Vulnerability</u>

Six preventive features have been credited in the determination of the scenario frequency and six mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the hardware control for an ***automatic sprinkler system*** in the West Dock Canopy Area (all receptors),

2 the Administrative Control to provide a ***combustible material control*** program [fire retardant wood on crates, five foot separation between combustibles and waste containers] (all receptors),

3 the Administrative Control for ***flammable gas container*** specifications (all receptors),

4 the Administrative Control for ***fire extinguisher*** placement and maintenance (MOI and CW),

5 the Administrative Control to provide an ***ignition source control*** program [restrictions on smoking in the facility, hot work permits, transport vehicle engines turned off when parked] (all receptors); and

6 the Administrative Control for ***electrical system maintenance*** to maintain current fire frequency assumptions (all receptors)

The credited mitigative features are

1 the Administrative Control of ***liners in wooden LLW crates*** (all receptors),

2 the Administrative Control of ***container radioactive material loading*** (all receptors),

3 the Administrative Control for ***wooden waste container*** specifications (all receptors),

4 the Administrative Control to provide a ***combustible material control*** program [fire retardant wood on crates] (all receptors),

5 the hardware control for an ***automatic sprinkler system*** in the West Dock Canopy Area (all receptors), and

6 the Administrative Control of an ***emergency plan*** (IW only)

Failures of the preventive features are already assessed in or bounded by the scenario frequency determination event tree process and will not be addressed further

Failures of the ***container radioactive material loading*** mitigative feature (higher MAR containers, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take almost 21 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 0048 rem to 0 1 rem) and even more MAR to change the CW consequence bin assignment (factor of about 38 to go from 0 66 rem to 25 rem) This equates to an average LLW crate inventory of over 63 grams in each of the four crates Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a factor of two or less do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is no change in scenario risk class due to failure of the ***container radioactive material loading*** mitigative feature

Failures of the ***wooden waste container*** and ***liners in wooden crates*** mitigative features (container fire resistance; one frequency bin reduction due to standardization of waste containers and waste container packaging) would result in a higher release fraction It would take almost 21 times the release to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 0048 rem to 0 1 rem) and even more release to change the CW consequence bin assignment (factor of about 38 to go from 0 66 rem to 25 rem) Wooden crates without liners are assumed to have release fractions that are one order of magnitude higher than the confined material fire release fractions (*i e*, 5E-03 versus 5E-04) Degraded wooden crates without liners (*i e*, nearly unconfined material) would have release fractions that are two orders of magnitude higher than the confined material release fractions (*i e*, 5E-02 versus 5E-04) Therefore, gross failures of the mitigative features would have to occur in order to lead to changes in the consequence bin assignments for the MOI and the CW Failures at that level, basically crates that are falling apart, are considered to be *beyond extremely unlikely* events More likely a few crates may not contain liners or a few crates may be damaged to the point that the liner can be directly exposed to fires Failures of this type do not change the consequence bin assignments for the receptors Therefore, for this situation, the risk class for the CW becomes Risk Class III (due to frequency reduction from mitigative feature failure concurrent with scenario but with no change to the consequence bin) and the risk classes for the MOI and IW become Risk Class IV (due to frequency reduction and maintenance of the *low* consequence bin) due to failures of the ***wooden waste container*** and ***liners in wooden crates*** mitigative features

Failures of the ***combustible material control*** mitigative feature dealing with use of non-fire retardant wooden crates (greater fire propagation potential, one frequency bin reduction due to standardization of waste containers) would result in additional MAR It would take almost 21 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 0048 rem to 0 1 rem) and even more MAR to change the CW consequence bin assignment (factor of about 38 to go from 0 66 rem to 25 rem) This equates to over 80 crates being involved in the fire that exceeds the Administrative Control limit of 50 crates in addition to failing the crate fire retardant control The combination of these two events concurrent with the accident scenario is considered to be a *beyond extremely unlikely* event More likely errors of a few crates without fire retardant wood do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, the risk class for the CW becomes Risk Class III (due to frequency reduction from mitigative feature failure

- ***LS/DW System*** (IW only) ***LS/DW system*** use can reduce IW consequences by providing indication of a fire to facility personnel Facility management may be informed by various alarms or the ***Fire Department*** or personnel may be aware of the fire and use the ***LS/DW system***

In summary, the analyzed accident scenario yields Risk Class II results for the CW and Risk Class III results for the MOI and the IW. Failures of individual mitigative features concurrent with the accident do not increase the risk class of the scenario for any receptor. For many cases, there is a risk class reduction for the CW from Risk Class II to Risk Class III and for the MOI and the IW from Risk Class III to Risk Class IV associated with the concurrent failures scenario

5.3.5 Facility Fire Scenario 4 - Major Wooden LLW Crate Facility Fire

This accident scenario is discussed below and is summarized in Table 88 located at the end of Section 5 3, *Facility Fire Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A facility fire is postulated to impact up to fifty wooden LLW crates (*Hazard/Energy Source 4B*) The facility fire may occur as a result of the presence of propane (*Hazard/Energy Source 5B*), natural gas (*Hazard/Energy Source 5C*), transport vehicles (*Hazard/Energy Source 5H*), or other combustibles (*Hazard/Energy Source 13F*) being ignited during the conduct of hot work, during the receipt or shipment of crates, or by exposure to electrical system components (*Hazard/Energy Source 5E*) The facility fire occurs in the West Dock Canopy Area The propane and natural gas hazards will be addressed in more detail in Section 5 7, *Facility Explosion Scenario Accident Analyses* The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste crates The wooden crates become involved in the fire and combust along with their contents that are assumed to be combustible The fire analysis assumes no fire suppression by the ***automatic sprinkler system*** due to failure of the system The fire is limited to fifty wooden crates due to a ***50 wooden LLW crate limit*** imposed on the Building 991 Complex The fire is expected to last for more than 30 minutes and is evaluated as a 30 minute release The fire is modeled as a confined material release due to the assumption that the ***wooden LLW crates have liners*** Due to the amount of heat energy associated with this fire (*i e*, on the order of 50 MW), a lofted plume release of the radioactive material is assumed

Scenario Modeling Assumptions fire, confined material, 30 minute duration, lofted plume

Material-At-Risk

Up to fifty wooden crates containing LLW are involved in the major facility fire scenario It is assumed that there is one or more failures of the ***combustible material control*** program and combustible materials are placed within five feet of a stack of wooden LLW crates Up to fifty crates are exposed to an unmitigated (*i e*, ***automatic sprinkler system*** fails) wooden crate fire No more than fifty crates are involved due to a ***50 wooden LLW crate limit*** for the complex Inherent in the assumption that the scenario can be modeled as a confined material release is the combined resistance of the ***wooden waste container*** and the ***liner inside the wooden LLW crate*** to fires of this type Based on General Assumption G2, no more than 3 grams (WG Pu equivalent) of radioactive material will be in a wooden LLW crate and this is imposed as a ***container radioactive material loading*** limitation A blended DCF of 3 07E+07 is used to conservatively account for the population mix of wooden waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y It is conservatively assumed that the entire container inventory of the fifty crates is involved in the accident scenario (*i e*, DR = 1)

Scenario Modeling Assumptions 50 crates, 150 grams, blended DCF, DR = 1

Accident Consequence

The radiological dose consequences of facility fires involving LLW containers were originally assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequence). Based on Table 2, the radiological dose consequences of unmitigated facility fires were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of a facility fire involving fifty wooden LLW crates are *low* (0 0068 rem) to the MOI and *low* (0.24 rem) to the CW The resulting risk classes for the scenario are Risk Class IV for both the MOI and the CW (*extremely unlikely* frequency, *low* consequence)

The IW located in the vicinity of the crate fire could have been seriously burned as a result of the scenario but the IW would almost have to come into close proximity of the burning material to be seriously impacted The more likely mechanism for IW serious injury or death deals with exposure of the IW to smoke leading to asphyxiation or to noxious components of the smoke This scenario occurs in high ceiling areas outside the facilities that would significantly delay IW smoke related impacts There is the potential for the IW to inhale radioactive material being carried in the effluent from the fire (0 075 grams) but the IW would have to remain in the vicinity of the fire or in the path of the effluent It would be relatively easy for the IW to vacate the area with minimum dose impact if the IW is not incapacitated The radiological dose consequences for the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated fires, due to (1) the low amount of radiological material that is released, (2) the indicators of a fire (*e g*, smoke, flames) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for the scenario is <u>Risk Class IV for the IW</u> (*extremely unlikely* frequency, *low* consequence)

The IW located in the facility but away from the accident will not be exposed to the facility fire (no burn potential) unless the IW evacuation path is through the accident area This latter concern is unlikely to be realized due to the layout of the facility with multiple exit paths from most areas A fire of this type is assumed to have sufficient heat energy to set off the automatic fire suppression system in the West Dock Canopy waste storage area but the system fails in the scenario Any personnel who become aware of the fire due to direct observation of smoke or flames can utilize ***fire phones*** to result in a facility ***fire alarm*** leading to evacuation of any facility IW unaware of the event per the facility ***emergency plan*** The consequences for the initially unaware IW are qualitatively judged to be *low* due to (1) the low amount of radiological material that is released, (2) the limited potential of fire detection/announcement devices (*e g* , ***fire phones***) that will provide signals to alarm functions, (3) the limited potential for indicators of a fire (*e g* , ***fire alarms***) that informs the IW of the event, (4) the limited potential for fire effluent to migrate into the facility, and (5) the building ***emergency plan*** that directs the fire-aware IW to evacuate No risk class designation for the initially unaware IW is provided

<u>Control Set Adequacy/Vulnerability</u>

Six preventive features have been credited in the determination of the scenario frequency and five mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the hardware control for an ***automatic sprinkler system*** in the West Dock Canopy Area (all receptors),

2 the Administrative Control to provide a ***combustible material control*** program [fire retardant wood on crates, five foot separation between combustibles and waste containers] (all receptors),

3 the Administrative Control for ***flammable gas container*** specifications (all receptors),

4 the Administrative Control for ***fire extinguisher*** placement and maintenance (MOI and CW),

5 the Administrative Control to provide an ***ignition source control*** program [restrictions on smoking in the facility, hot work permits, transport vehicle engines turned off when parked] (all receptors), and

6 the Administrative Control for ***electrical system maintenance*** to maintain current fire frequency assumptions (all receptors)

The credited mitigative features are

1 the Administrative Control of ***liners in wooden LLW crates*** (all receptors),

2 the Administrative Control of ***container radioactive material loading*** (all receptors),

3 the Administrative Control for ***wooden waste container*** specifications (all receptors),

4 the Administrative Control to ensure a ***50 wooden LLW crate limit*** for the complex (all receptors), and

5 the Administrative Control of an ***emergency plan*** (IW only)

Failures of the preventive features are already assessed in or bounded by the scenario frequency determination event tree process and will not be addressed further

Failures of the ***container radioactive material loading*** mitigative feature (higher MAR containers, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take almost 2 times the MAR to be involved in an accident scenario to yield a change in the CW dose consequence bin assignment (from 0.24 rem to 0 5 rem) and even more MAR to change the MOI consequence bin assignment (factor of about 15 to go from 0 0068 rem to 0 1 rem) This equates to an average LLW crate inventory of over 6 grams in each of the fifty crates Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a factor of two or less in a limited number of crates do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is <u>no change in scenario risk class</u> due to failure of the ***container radioactive material loading*** mitigative feature

Failures of the ***wooden waste container*** and ***liners in wooden crates*** mitigative features (container fire resistance, one frequency bin reduction due to standardization of waste containers and waste container packaging) would result in a higher release fraction Since the scenario was determined to be an *extremely unlikely* event, combination failures of the ***wooden waste container*** and ***liners in wooden crates*** mitigative features concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***50 wooden LLW crate limit*** mitigative feature (additional crates, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take almost 2 times the MAR to be involved in an accident scenario to yield a change in the CW dose consequence bin assignment (from 0 24 rem to 0 5 rem) and even more MAR to change the MOI consequence bin assignment (factor of about 15 to go from 0 0068 rem to 0 1 rem) This equates to over 100 crates being involved in the fire Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a few additional crates do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is <u>no change in scenario risk class</u> due to failure of the ***50 wooden LLW crate limit*** mitigative feature

Failures of the ***emergency plan*** mitigative feature (inadequate plan, one frequency bin reduction due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials Since the scenario was determined to be an *extremely unlikely* event, failure of the ***emergency plan*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of incorrect introduction or placement of combustibles

- ***Flow Alarm/Fire Department Response*** (MOI and CW only) For fires in areas covered by the ***automatic sprinkler system, flow alarm*** transmittal to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** Sprinkler response may occur in the West Dock Canopy Area

- ***Fire Phones/Fire Department Response*** (MOI and CW only) ***Fire phone*** communication to the Fire Dispatch Center can lead to scenario mitigation due to ***Fire Department response*** There is a possibility that the fire will be noticed by personnel but the most likely scenario would not have personnel detection of the fire

- ***Training*** (IW only) The IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***Fire Phones/Local Fire Alarm*** (IW only) ***Fire phone*** use activates ***local fire alarms*** and can reduce IW consequences by providing indication of a fire to facility personnel There is a possibility that the fire will be noticed by personnel who will use a ***fire phone*** but the most likely scenario would not have personnel detection of the fire

In order to assure protection of the MOI and the CW against fires that are larger than the analyzed 50 wooden waste crate fire (*e g*, fire spreading into Room 170 or non-lofted plume from slower burning fire), the ***flow alarm/Fire Department response*** control will be considered as a credited mitigative feature (*i e*, no longer only serve as defense-in-depth feature, see Feature F26 in Table 84)

In summary, the analyzed accident scenario yields Risk Class IV results for the MOI, the CW, and the IW Failures of individual mitigative features concurrent with the accident do not increase the risk class of the scenario for any receptor

5.3.6 Facility Fire Scenario 5 - Medium TRU Waste Drum Transport Vehicle Facility Fire

This section deleted based on evaluation provided in the *Salt Stabilization Program Transportation Risk* (Ref 35) report and in the *Evaluation of Risk Associated with Transportation Activities within the Protected Area* (Ref 36)

5.3.7 Facility Fire Scenario Assumptions, Features, Requirements

In the evaluation of facility fire scenarios, assumptions, protective features, and requirements were identified for prevention and/or mitigation of the accidents This information is found in Section 4 3 6 2, *Bounding Facility Fire Scenarios Determination*, in Section 5 3 1, *Facility Fire Scenario Development and Selection*, in Section 5 3 2, *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire*, in Section 5 3 3, *Facility Fire Scenario 2 – 2 MW TRU Waste Drum Facility Fire*, in Section 5 3 4, *Facility Fire Scenario 3 - Medium to Large Wooden LLW Crate Facility Fire*, and in Section 5 3 5, *Facility Fire Scenario 4 - Major Wooden LLW Crate Facility Fire* Table 84 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of facility fire scenarios The scenarios to which each assumption, feature, or requirement applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 84 Assumptions/Features/Requirements for Facility Fire Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G2	LLW containers contain no more than 0 5 grams (WG Pu equivalent) in metal drums and 3 grams in wooden or metal boxes	Facility Fire Scenario 3 Facility Fire Scenario 4	Sets the potential MAR for many scenarios impacting LLW containers (3 grams for spills, punctures, and criticality potential) ***Container Radioactive Material Loading***
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Facility Fire Scenario 1 Facility Fire Scenario 2	Sets the potential MAR for many scenarios impacting waste containers (200 grams for facility fires and container explosions, 320 grams for facility fires, spills, punctures, container explosions, and criticality potential) ***Container Radioactive Material Loading***
A18	Propane or other flammable gas torches are *unlikely* to breach both the outer drum and the inner pipe component of a POC container without intentional flame direction	B-FFIRE-3	Reduces the likelihood of POC container failure from scenarios dealing with flammable gas torch direct flame impingement breach of the container by one frequency bin

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Table 84 Assumptions/Features/Requirements for Facility Fire Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F15	Type B shipping containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	B-FFIRE-1	Reduces the likelihood of Type B shipping container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely* ***Type B Shipping Container***
F16	POC containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	B-FFIRE-1	Reduces the likelihood of POC container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely* ***POC Container***
F17	Flammable gas containers are *unlikely* to be breached during use	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of explosion or fire scenarios due to use of flammable gases by one frequency bin ***Flammable Gas Container***
F20	Office area fires are prevented from propagating to waste storage areas by a combination of fire barriers and fire doors	B-FFIRE-1	Reduces the likelihood of fire propagation from the Office Area to waste storage areas by one frequency bin ***Office Area to Waste Area Fire Doors***
F21	Fire extinguishers are available and well maintained to allow personnel fire suppression actions	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fire growth from the small fires to medium fires by one frequency bin ***Fire Extinguishers***
F22	Automatic sprinkler systems are located in all waste storage areas, except Building 996, and in the Office Areas and are well maintained	B-FFIRE-1 Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fire growth from the medium fires to larger fires by one frequency bin ***Automatic Sprinkler Systems***
F23	Metal waste container lids cannot be removed from the containers due to internal overpressurize from exposure to expected fires	Facility Fire Scenario 1 Facility Fire Scenario 2	Reduces the likelihood of metal waste container fire-induced lid loss associated with expected fires to *Beyond Extremely Unlikely* ***Metal Waste Container***

Table 84 Assumptions/Features/Requirements for Facility Fire Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F24	Metal waste container fires cannot propagate from container to container by exposure to expected fires	Facility Fire Scenario 1 Facility Fire Scenario 2	Reduces the likelihood of metal waste container fire container-to-container propagation associated with expected fires to *Beyond Extremely Unlikely* ***Metal Waste Container***
F25	Wooden waste containers prevent direct exposure of fires to container contents for expected fires	Facility Fire Scenario 3 Facility Fire Scenario 4	In combination with ***wooden waste crate liners***, reduces the consequences from LLW crate fires by two orders of magnitude ***Wooden Waste Container***
F26	Actuation of the automatic sprinkler systems will yield a flow alarm at the Fire Dispatch Center and will result in Fire Department response	Facility Fire Scenario 2 Facility Fire Scenario 4	Reduces the consequences of fires larger than those analyzed in the safety analysis ***Flow Alarms/Fire Department Response***
F27	Actuation of the smoke detection system will yield an alarm at the Fire Dispatch Center and will result in Fire Department response	Facility Fire Scenario 2	Reduces the consequences of fires larger than those analyzed in the safety analysis in Building 996 waste container storage areas ***Smoke Detectors/Fire Department Response***
R2	Propane or other flammable gases are prohibited from vaults while SNM is present	B-FFIRE-3	Reduces the likelihood of Type B shipping container breaches associated with direct flame impingement from torches to *Beyond Extremely Unlikely*
R3	Work controls are required to ensure that waste container direct exposure to propane or other flammable gas flames is an *extremely unlikely* event	B-FFIRE-1	Reduces the likelihood of metal waste container failure from scenarios dealing with direct exposure to flammable gases (*i e*, torches) to *Extremely Unlikely*

Table 84 Assumptions/Features/Requirements for Facility Fire Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R8	A combustible material and ignition source control program shall be implemented to make fires in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	B-FFIRE-3 Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of facility fires potentially impacting radioactive material to *Unlikely*
R8a	Elements of combustible material control include • high heat release rate combustible material restrictions, • no wooden crates in internal waste storage areas, • combustibles have five foot separation from waste containers •		
R8b	Elements of ignition source control include • restrictions on smoking in facilities, • hot work permits •		
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the exposure of the IW to releases ***Emergency Plan***
R15	Electrical systems in the Building 991 Complex are maintained sufficiently to prevent fires from hot shorts becoming *anticipated* events	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fires from electrical system failures to *unlikely* or *extremely unlikely* events ***Electrical System Maintenance***
R16	All wooden LLW crates stored in the Building 991 Complex shall have liners	Facility Fire Scenario 3 Facility Fire Scenario 4	In combination with ***wooden waste container***, reduces the consequences from LLW crate fires by two orders of magnitude ***Wooden Waste Crate Liners***

Table 84 Assumptions/Features/Requirements for Facility Fire Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R17	No more than 50 wooden LLW crates may be stored in the West Dock Canopy waste storage area	Facility Fire Scenario 4	Limits the consequences from major LLW crate fires ***50 Wooden LLW Crate Limit***

Table 85 Facility Fire Scenario 1 - 1 MW TRU Waste Drum Facility Fire

Hazard	4B (Radioactive Materials/Waste Container), 5B (Thermal Energy/Propane), 5C (Thermal Energy/Natural Gas), and 13F (Other Hazards/Combustibles)
Accident Type	Facility Fire involving up to 3 TRU waste drums, fire involves combustibles in close proximity to waste containers in internal waste storage areas, Effective MAR = 600 grams of aged WG Pu, bounding accident could occur in any of the waste storage areas
Cause or Energy Source	[energy sources] 5E (Electric Power System) and hot work
Applicable Activity(ies)	[most likely] MAINT, [less likely] CHEM, CON, GEN, WASTE, and RA

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
MOI	Unlikely	Unlikely	High	Moderate 0 26 rem	I	II	Combustible Material Control [R8]	C	P/M	AC 5 3
							Ignition Source Control [R8]	C	P	AC 5 3
							Flammable Gas Containers [F17]	C	P	AC 5 3
							Electrical System Maintenance [R15]	C	P	MAINT
							No Wooden Crates [R8a]	C	P	AC 5 3
							Fire Extinguishers [F21]	C	P	AC 5 4
							Automatic Sprinkler System [F22]	C	P/M	LCO 3 1
							Metal Waste Container [F23/F24]	C	M	AC 5 2
							Container Rad Material Loading [G4]	C	M	AC 5 2
							Training	D	P	TRAIN
							Flow Alarm/Fire Department Response	D	M	AC 5 5
							Smoke Detectors/Fire Depart Response	D	M	AC 5 5
							Fire Phones/Fire Department Response	D	M	AC 5 5
							Filtered Exhaust Ventilation	D	M	AC 5 5
CW	Unlikely	Unlikely	High	High 35 rem	I	I	Same as MOI			
IW	Unlikely	Unlikely	<u>Moderate</u>	Low	<u>II</u>	III	Combustible Material Control [R8]	C	P	AC 5 3
							Ignition Source Control [R8]	C	P	AC 5 3
							Flammable Gas Containers [F17]	C	P	AC 5 3
							Electrical System Maintenance [R15]	C	P	MAINT
							Emergency Plan [R12]	C	M	AC 5 6
							Metal Waste Container [F23/F24]	C	M	AC 5 2
							Container Rad Material Loading [G4]	C	M	AC 5 2
							Training	D	P/M	TRAIN
							Water Gong Alarm/Automatic Sprinklers	D	M	AC 5 5
							Smoke Detectors/LS/DW	D	M	AC 5 5
							Fire Phones/Local Fire Alarm	D	M	AC 5 5

[1] Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

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Table 86 Facility Fire Scenario 2 - 2 MW TRU Waste Drum Facility Fire

<table>
<tr><td>Hazard</td><td colspan="10">4B (Radioactive Materials/Waste Container), 5B (Thermal Energy/Propane), 5C (Thermal Energy/Natural Gas), and 13F (Other Hazards/Combustibles)</td></tr>
<tr><td>Accident Type</td><td colspan="10">Facility Fire involving up to 6 TRU waste drums, fire involves combustibles in close proximity to waste containers in waste storage areas,
Effective MAR = 1,200 grams of aged WG Pu, bounding accident occurs in Room 170</td></tr>
<tr><td>Cause or Energy Source</td><td colspan="10">[energy sources] 5E (Electric Power System) and hot work</td></tr>
<tr><td>Applicable Activity(ies)</td><td colspan="10">[most likely] MAINT, [less likely] CHEM, CON, GEN, WASTE, and RA</td></tr>
<tr><td rowspan="2">Receptor</td><td colspan="2">Scenario Frequency</td><td colspan="2">Scenario Consequence</td><td colspan="2">Scenario Risk Class</td><td rowspan="2">Protective Feature[1]</td><td rowspan="2">Feature Type Credited Defense</td><td rowspan="2">Feature Purpose Prevent Mitigate</td><td rowspan="2">Reference to TSRs</td></tr>
<tr><td>Without Prevention[1]</td><td>With Prevention</td><td>Without Mitigation[1]</td><td>With Mitigation</td><td>Without Prevention/ Mitigation</td><td>With Prevention/ Mitigation</td></tr>
<tr><td>MOI</td><td>Unlikely</td><td>Extremely Unlikely</td><td>High</td><td>Moderate
0 52 rem</td><td>I</td><td>III</td><td><u>Combustible Material Control</u> [R8]
<u>Ignition Source Control</u> [R8]
<u>Flammable Gas Containers</u> [F17]
<u>Electrical System Maintenance</u> [R15]
No Wooden Crates [R8a]
Fire Extinguishers [F21]
Metal Waste Container [F23/F24]
Container <u>Rad</u> Material Loading [G4]
<u>Automatic Sprinkler System [F22]</u>
<u>Flow Alarm/Fire Department [F26]</u>
<u>Smoke Detectors/Fire Department [F27]</u>
Training
Fire Phones/Fire Department Response</td><td>C
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<u>M</u>
P
M</td><td>AC 5 3
AC 5 3
AC 5 3
MAINT
AC 5 3
AC 5 4
AC 5 2
AC 5 2
<u>LCO 3 1</u>
<u>LCO 3 1</u>
<u>LCO 3 1</u>
TRAIN
AC 5 5</td></tr>
<tr><td>CW</td><td>Unlikely</td><td>Extremely Unlikely</td><td>High</td><td>High
71 rem</td><td>I</td><td>II</td><td>Same as MOI</td><td></td><td></td><td></td></tr>
<tr><td>IW</td><td>Unlikely</td><td>Extremely Unlikely</td><td><u>Moderate</u></td><td>Low</td><td><u>II</u></td><td>IV</td><td><u>Combustible Material Control</u> [R8]
<u>Ignition Source Control</u> [R8]
<u>Flammable Gas Containers</u> [F17]
<u>Electrical System Maintenance</u> [R15]
Emergency Plan [R12]
Metal Waste Container [F23/F24]
Container <u>Rad</u> Material Loading [G4]
Training
Water Gong Alarm/Automatic Sprinklers
Fire Phones/Local Fire Alarm</td><td>C
C
C
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C
C
C
D
D
D</td><td>P
P
P
P
M
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M
P/M
M
M</td><td>AC 5 3
AC 5 3
AC 5 3
MAINT
AC 5 6
AC 5 2
AC 5 2
TRAIN
AC 5 5
AC 5 5</td></tr>
</table>

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

Table 87 Facility Fire Scenario 3 - Medium to Large Wooden LLW Crate Facility Fire

Hazard	4B (Radioactive Materials/Waste Container), 5B (Thermal Energy/Propane), 5C (Thermal Energy/Natural Gas), 5H (Thermal Energy/Transport Vehicles), and 13F (Other Hazards/Combustibles)
Accident Type	Facility Fire involving up to 4 wooden LLW crates, fire involves combustibles in close proximity to waste crates in outside canopy covered areas, Effective MAR = 12 grams of aged WG Pu, accident occurs in West Dock Canopy waste storage area.
Cause or Energy Source	[energy sources] 5E (Electric Power System), 5H (Transport Vehicles), and hot work
Applicable Activity(ies)	[most likely] WASTE and MAINT, [less likely] CHEM, CON, GEN, and RA

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation	With Prevention/ Mitigation				
MOI	Unlikely	Unlikely	High	Low 0 0048 rem	I	III	<u>Combustible Material Control</u> [R8]	C	P/M	AC 5 3
							<u>Ignition Source Control</u> [R8]	C	P	AC 5 3
							<u>Flammable Gas Containers</u> [F17]	C	P	AC 5 3
							<u>Electrical System Maintenance</u> [R15]	C	P	MAINT
							Fire Extinguishers [F21]	C	P	AC 5 4
							Automatic Sprinkler System [F22]	C	P/M	LCO 3 1
							Wooden Waste Container [F25]	C	M	AC 5 2
							Wooden Waste Crate Liners [R16]	C	M	AC 5 2
							Container <u>Rad</u> Material Loading [G2]	C	M	AC 5 2
							Training	D	P	TRAIN
							Flow Alarm/Fire Department Response	D	M	AC 5 5
							Fire Phones/Fire Department Response	D	M	AC 5 5
CW	Unlikely	Unlikely	High	Moderate 0 66 rem	I	II	Same as MOI			
IW	Unlikely	Unlikely	<u>Moderate</u>	Low	<u>II</u>	III	<u>Combustible Material Control</u> [R8]	C	P/M	AC 5 3
							<u>Ignition Source Control</u> [R8]	C	P	AC 5 3
							<u>Flammable Gas Containers</u> [F17]	C	P	AC 5 3
							<u>Electrical System Maintenance</u> [R15]	C	P	MAINT
							Emergency Plan [R12]	C	M	AC 5 6
							Automatic Sprinkler System [F22]	C	P/M	LCO 3 1
							Wooden Waste Container [F25]	C	M	AC 5 2
							Wooden Waste Crate Liners [R16]	C	M	AC 5 2
							Container <u>Rad</u> Material Loading [G2]	C	M	AC 5 2
							Training	D	P/M	TRAIN
							Water Gong Alarm/Automatic Sprinklers	D	M	AC 5 5
							LS/DW	D	M	AC 5 5
							Fire Phones/Local Fire Alarm	D	M	AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

Table 88 Facility Fire Scenario 4 - Major Wooden LLW Crate Facility Fire

Hazard	4B (Radioactive Materials/Waste Container), 5B (Thermal Energy/Propane), 5C (Thermal Energy/Natural Gas), 5H (Thermal Energy/Transport Vehicles), and 13F (Other Hazards/Combustibles)
Accident Type	Facility Fire involving up to 50 wooden LLW crates, fire involves combustibles in close proximity to waste crates in outside canopy covered areas, Effective MAR = 150 grams of aged WG Pu, accident occurs in West Dock Canopy waste storage area, 30 minute duration fire with lofted plume
Cause or Energy Source	[energy sources] 5E (Electric Power System), 5H (Transport Vehicles), and hot work
Applicable Activity(ies)	[most likely] WASTE and MAINT, [less likely] CHEM, CON, GEN, and RA

Receptor	Scenario Frequency: Without Prevention[1]	Scenario Frequency: With Prevention	Scenario Consequence: Without Mitigation[1]	Scenario Consequence: With Mitigation	Scenario Risk Class: Without Prevention/ Mitigation	Scenario Risk Class: With Prevention/ Mitigation	Protective Feature	Feature Type: Credited Defense	Feature Purpose: Prevent Mitigate	Reference to TSRs
MOI	Unlikely	Extremely Unlikely	High	Low 0 0068 rem	I	IV	Combustible Material Control [R8]	C	P	AC 5 3
							Ignition Source Control [R8]	C	P	AC 5 3
							Flammable Gas Containers [F17]	C	P	AC 5 3
							Electrical System Maintenance [R15]	C	P	MAINT
							Fire Extinguishers [F21]	C	P	AC 5 4
							Automatic Sprinkler System [F22]	C	P	LCO 3 1
							Wooden Waste Container [F25]	C	M	AC 5 2
							Wooden Waste Crate Liners [R16]	C	M	AC 5 2
							Container Rad Material Loading [G2]	C	M	AC 5 2
							50 Wooden LLW Crate Limit [R17]	C	M	AC 5 2
							Flow Alarm/Fire Department [F26]	C	M	LCO 3 1
							Training	D	P	TRAIN
							Fire Phones/Fire Department Response	D	M	AC 5 5
CW	Unlikely	Extremely Unlikely	High	Low 0 24 rem	I	IV	Same as MOI			
IW	Unlikely	Extremely Unlikely	Moderate	Low	II	IV	Combustible Material Control [R8]	C	P	AC 5 3
							Ignition Source Control [R8]	C	P	AC 5 3
							Flammable Gas Containers [F17]	C	P	AC 5 3
							Electrical System Maintenance [R15]	C	P	MAINT
							Emergency Plan [R12]	C	M	AC 5 6
							Automatic Sprinkler System [F22]	C	P	LCO 3 1
							Wooden Waste Container [F25]	C	M	AC 5 2
							Wooden Waste Crate Liners [R16]	C	M	AC 5 2
							Container Rad Material Loading [G2]	C	M	AC 5 2
							50 Wooden LLW Crate Limit [R17]	C	M	AC 5 2
							Training	D	P/M	TRAIN
							Fire Phones/Local Fire Alarm	D	M	AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

5.4 SPILL SCENARIO ACCIDENT ANALYSES

5.4.1 Spill Scenario Development and Selection

Two bounding spill scenarios were identified in Section 4 3 6 3, *Bounding Spill Scenarios Determination* The first spill scenario, B-SPILL-1, involves the *anticipated* spill of a single waste container or a single pallet of waste containers (for each of LLW and TRU waste containers) The second, B-SPILL-2, involves the *unlikely* spill (for each of LLW and TRU waste containers) or an *extremely unlikely* spill (for POC containers) of an entire room or area of waste containers and/or POCs resulting from facility structural failures Each of these bounding scenarios are further defined in the following discussions

5.4.1.1 Waste Container Drop/Fall Spill Scenario Development and Selection

Further evaluation of this scenario is required to determine the bounding waste container configuration (*e g*, single container, pallet of containers) or type of waste container (*e g*, 55-gallon drum, TRUPACT II SWB, metal waste crate, wooden waste crate) that should be used for scenario evaluation

Spills from waste containers can be caused by drops/falls during movement from raised forklift tines, drops/falls from upper tiers of stacks due to stack impacts, and from impact by vehicles during movement or while being stored It is assumed that drops or falls of distances greater than four feet are necessary to cause damage to the container whereby a release of radioactive material is possible Waste containers stored in the Building 991 Complex meet on-site transportation requirements (*i e*, the containers either meet Type A specifications (qualified for a 4 foot drop) or are considered equivalent to Type A containers) For 55-gallon waste containers, this assumption implies that drums being stacked on the third or fourth tiers, or drums that are impacted and fall from the third or fourth tiers, are susceptible to breach resulting in a radioactive release Wooden and metal waste crates are only stacked two high in the Building 991 Complex. The height of these waste containers is approximately four feet, therefore, this assumption implies that these containers are susceptible to drops/falls that could result in a radioactive release if they are being stacked on the second tier There are various locations within the complex where stacking of drums above the second tier is permissible This includes Room 134 (4-high), Room 140/141 (3-high), Room 143 (3-high), Room 151 (3-high), Room 166 (4-high), and Room 170 (4-high) Wooden and metal waste crates may be stacked 2-high in various locations throughout the facility For wooden waste crates this will only occur outside under the covered West Dock Canopy Area Metal waste crates (TRUPACT II SWB containers and metal waste boxes) may be stored in any of the storage areas that are capable of accommodating them due to their size This will normally be in locations such as Room 134, Room 140/141, Room 166, and Room 170

It is assumed that 100% of the contents of a waste container are available for release as a result of a drop/fall of greater than 4 feet This is considered conservative since this assumption implies that the top of the container is lost due to the impact of the waste container with the hard surface that allows the internal packaged material to release its radioactive material For the TRUPACT II SWB containers and metal waste crates, this is considered a conservative assumption since they would be dropped or would fall from a height of just a little more than four feet In a drop/fall of a pallet of banded drums, it is assumed that one of the four drums is breached and would have all of its contents available for release (intended to bound breaches of multiple drums with limited content release from each) In the banded configuration the assumption is that one drum takes the full brunt of the impact with the hard surface with the weight of the other drums contributing to the impact forces on the drum A drop/fall of un-banded drums from a distance greater than four feet could conceivably breach each of the containers that drop/fall

Therefore, as shown in Table 90, the estimated effective MAR for the different container configurations that may be involved in a drop/fall is used to determine the bounding drop/fall scenario to evaluate

Table 90 Drop/Fall Spill Scenario Effective MAR

CONTAINER TYPE	CONTAINER CONFIGURATION	MAXIMUM MAR (WG Pu equivalent)	EFFECTIVE MAR (WG Pu equivalent)
Wooden LLW crate	single	3 grams	3 grams
Metal LLW crate	single	3 grams	3 grams
Metal LLW drum	single	0 5 grams	0 5 grams
Metal LLW drum	pallet, 4 containers, banded	2 grams	0 5 grams
Metal LLW drum	pallet, 4 containers, un-banded	2 grams	2 grams
TRUPACT II SWB or metal waste box	single	320 grams	320 grams
TRU drum	single	200 grams	200 grams
TRU drum	pallet, 4 containers, banded	800 grams	200 grams
TRU drum	pallet, 4 containers, un-banded	800 grams	800 grams

Therefore, for the first spill scenario, the bounding scenario requiring further evaluation is the drop/fall of a pallet of un-banded TRU drums The bounding spill scenario that will be further analyzed is

> **Spill Scenario 1 - TRU Waste Drums Drop/Fall:** This spill involves the contents of four 55-gallon waste drums These drums are assumed to be breached due to impact with a concrete surface from a drop/fall from a height greater than four feet The four drums are un-banded and on a pallet that is being stacked on the third tier or the stacked drums are impacted by material handling equipment and four drums fall from the third tier This scenario bounds other mechanisms for container breach due to the *anticipated* frequency of the scenario and due to the effective MAR involved in this scenario

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5.4.1.2 Facility Structural Failure Spill Scenario Development and Selection

The second spill scenario involves the structural failure of the Building 991 Complex tunnels (Corridor C) or the failure of the hallway (Room 153) floor where waste containers are going to be stored (east-west running hallway north of Room 140/141) Since ***storage of waste containers in Corridor C is prohibited***, the only structural failure scenario that needs to be further analyzed is failure of the hallway floor due to overloading Two cases have been carried forward from the hazard evaluation bounding scenario discussion The first case that needs to be evaluated is the *unlikely* scenario that damage to LLW or TRU waste containers occurs when the floor collapses The second case involved the *extremely unlikely* scenario that damage to the POC containers could occur when the hallway floor fails

The first case is further bounded by the type of container stored in the hallway (*i e*, LLW or TRU waste 55-gallon drum) Since the TRU waste container can have up to 200 grams WG Pu equivalent, versus 0 5 grams WG Pu equivalent for the LLW container, all scenarios involving the TRU waste containers bound the LLW containers

In the second case, testing has shown that the POC containers are not susceptible to damage from 30 foot drops but may be susceptible to damage from falling debris of a concrete structure that could occur during building collapse Structural failure of the hallway floor will result in a drop of approximately 10 feet but will not subject the POC to any falling debris It can reasonably be expected that the POCs will survive this drop without being breached based upon the testing previously conducted Since the POC containers will also not be subjected to falling debris during the hallway floor failure, it is expected that the POC will not contain the momentum required to result in a breach of the container Therefore, breaching of the POC is considered a *beyond extremely unlikely* event and further analysis for this spill scenario is not required

The bounding spill scenario that will be further analyzed is

Spill Scenario 2 - Facility Structural Failure Spill: This scenario involves 55-gallon TRU waste drums being breached due to structural failure of the hallway where the waste containers are stored This scenario bounds other mechanisms for facility structural failure caused spills due to the *unlikely* (based on TRU waste drums) frequencies associated with the scenario

5.4.2 Spill Scenario 1 - TRU Waste Drums Drop/Fall

This accident scenario is discussed below and is summarized in Table 92 located at the end of Section 5 4, *Spill Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A spill is postulated to occur as a result of breaching up to four 55-gallon TRU waste drums containing radioactive material (*Hazard/Energy Source 4B*). The breach of the drums may occur as a result of the drums being raised on a forklift (*Hazard/Energy Source 8B*) and falling from that position, or as a result of being stacked on the third or fourth tier (*Hazard/Energy Source 8C*) and then being impacted by material handling equipment (*Hazard/Energy Source 7A*) during operations being conducted in the facility Upon impact with the hard surface, the drums are damaged and opened, and the waste packages in the drums are breached by the weight of the waste packages and the force of the impact This is considered a confined material release since it is postulated the material is released upon impact and the packaging (drum and polyethylene bag) will contain some of the material from being released to the atmosphere

Due to stacking configurations, this scenario is postulated to occur in those areas where stacking above the second tier may occur These areas include Room 134 (4-high), Room 140/141 (3-high), Room 143 (3-high), Room 151 (3-high), Room 166 (4-high), or Room 170 (4-high)

Scenario Modeling Assumptions spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The evaluated scenario frequency is *anticipated* since dropping of waste containers has occurred in the past This is judged a conservative application of Site data as the majority of past events have been of relatively low energy, typically resulting in the denting of containers, dropping of containers with no loss of containment, *etc* Waste containers brought into the Building 991 Complex must meet ***metal waste container*** specifications (*i e*, on-site transportation requirements), therefore, actual breaches of containers due to drops/falls are probably less likely than *anticipated* due to the strength of the waste containers The analyzed scenario likelihood conservatively remains an *anticipated* event

Scenario Modeling Assumptions *anticipated* event

Material-At-Risk

The evaluated MAR for this scenario is 800 grams (WG Pu equivalent) ***Container radioactive material loading*** for the Building 991 Complex allows up to 200 grams (WG Pu equivalent) to be contained in each TRU drum brought into the complex Drums meeting ***metal waste container*** specifications (*i e*, on-site transportation requirements) are assumed to withstand a drop/fall from four feet or less without breaching Therefore, drums stacked on the third or fourth tiers are susceptible to breaching if they are dropped or fall Up to four drums may be on a pallet when they are moved or stored in the facility This scenario assumes that an un-banded pallet of four TRU waste drums is either being lifted by a forklift truck to be stacked on the third or fourth tier and the pallet is dropped or that an un-banded pallet of TRU waste drums stored on the third or fourth tier is accidentally impacted by material handling equipment and falls to the floor

The DR for TRU waste drums is assumed to be 100% These assumptions result in an effective MAR of 800 grams (4 drums x 200 grams/drum x 100%) for the evaluated scenario

The analyzed scenario takes credit for ***banding*** of drums that are going to be stacked on the third or fourth tier This reduces the effective MAR for this scenario to 200 grams This scenario assumes that the pallet drops/falls in such a configuration that one drum on the pallet is the first to impact the hard surface and that the weight of the other three drums is borne by the drum that impacts the floor. This results in the release of the entire contents of the first drum to impact the hard surface These assumptions are expected to bound breaches of multiple drums with limited content release from each drum

The solubility class for this scenario is conservatively assumed to be Solubility Class W

Scenario Modeling Assumptions 4 drums, aged WG Pu, 800 grams, Solubility Class W, DR = 0 25

Accident Consequences

The radiological dose consequences of spills involving TRU waste containers were originally assessed to be ***high*** for both the MOI and CW since the evaluated MAR was greater than 157 grams (WG Pu equivalent) This yielded an initial risk class for the scenario of Risk Class I for both receptors (*anticipated* frequency, ***high*** consequences) Based on Table 2, the radiological dose consequences of unmitigated spills were originally assessed to be ***moderate*** for the IW This yielded an initial risk class for the scenario of Risk Class I for the IW (*anticipated* frequency, *moderate* consequence)

The analyzed radiological dose consequences of the spill involving one 55-gallon TRU waste drum, taking credit for ***banding*** of waste containers that are to be stacked above the second tier, are *low* (0 023 rem) to the MOI and *moderate* (3.1 rem) to the CW The resulting risk class for the scenario is Risk Class III for the MOI (*anticipated* frequency, *low* consequences) and Risk Class I for the CW (*anticipated* frequency, *moderate* consequences)

For the IW located in the vicinity at the time of the event, the drop/fall of 55-gallon waste drums could hypothetically cause serious injury to those either driving the forklift or standing near the containers The radiological dose consequences of the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated spills, due to (1) the limited radiological material that is released due to ***container radioactive material loading*** limits, (2) the indicators of an accident (*i e*, toppled drums, noise) that informs the IW of the event, and (3) the building ***emergency plan*** and ***radiation protection*** guidance that directs the IW to evacuate These controls mitigate the consequences of the event to the IW The resulting risk class for this scenario is Risk Class III to the IW (*anticipated* frequency, *low* consequences)

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The IW located in the facility but away from the accident will not be exposed to the waste container drop/fall event (no injury potential) but could be exposed to a radiological release from the breached waste containers There are no systems in the facility that will provide warning to the IW in the facility but away from the accident However, the mechanisms that are identified for initiation of this event deal with the stacking of containers or with the impact with stacked containers by material handling equipment that requires personnel participation These personnel, unless incapacitated, will be able to make an announcement over the ***LS/DW system*** leading to evacuation, per the facility ***emergency plan***, of any facility IW unaware of the event The consequences for the initially unaware IW are qualitatively judged to be ***low*** due to (1) the limited radiological material that is released due to ***container radioactive material loading*** limits, (2) the potential for announcements (*i e*, ***LS/DW***) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate. No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

One preventive feature has been credited in the determination of scenario frequency and four mitigative features have been credited in determination of scenario consequences

The credited preventive feature is

1 the Administrative Control for ***metal waste container*** specifications (all receptors)

The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors),

2 the Administrative Control for ***banding*** of pallets of drums located on the third or fourth tiers,

3 the Administrative Control for ***radiation protection*** (IW only), and

4 the Administrative Control for ***emergency plan*** (IW only)

Failure of the ***metal waste container*** preventive feature (inadequate container, one frequency bin reduction) could increase the likelihood that a waste container breach could occur due to a drop/fall event from a height less than four feet The likelihood of a breach due to a container drop/fall from less than four feet is considered a *beyond extremely unlikely* event if the container specifications are met The less than 4 foot drop breach likelihood could increase to an *anticipated* event if the container is degraded A conservative *anticipated* event likelihood is already considered for breaches of waste containers stacked higher than four feet If waste containers could be breached from drops/falls of less than four feet, the risk class decreases to Risk Class II for the CW due to the frequency bin reduction Therefore, for this situation, the risk class for the CW becomes Risk Class II (due to frequency reduction and unchanged *moderate* consequence bin), the risk class for the MOI and the IW remains Risk Class III due to failure of the ***metal waste container*** preventive feature

Failure of the ***container radioactive material loading*** mitigative feature (underestimation of existing container inventory, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take 4 3 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (0 023 rem to 0 1 rem) and 8 times the MAR to change the CW dose consequence bin assignment (3 1 rem to 25 rem) This equates to a container inventory of 860 grams Inventory errors this large are considered to be *beyond extremely unlikely* events More likely errors of a factor of two or less do not change the scenario consequence bin assignment for any receptor Therefore, for this situation, there is no change in scenario risk class due to failure of the ***container radioactive material loading*** mitigative feature

Failure of the ***banding*** mitigative feature (drums stacked in un-banded configuration, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR Without banding, drums being stacked on the third or fourth tiers, or those stacked on these tiers, could all potentially be involved in the drop/fall event Conservatively, it is assumed that the entire contents of the drums that are dropped or fall is available for release This makes the un-banded event a factor of four higher in MAR (800 grams versus 200 grams) and increases the dose consequences a factor of four (0 092 rem versus 0 023 rem for the MOI and 12 4 rem versus 3 1 rem for the CW) This increase in dose does not change the consequence bin assignment for either the MOI or the CW Therefore, failure of the ***banding*** mitigative feature does increase the dose consequences but does not change the scenario risk class

Failures of the ***radiation protection*** or the ***emergency plan*** mitigative features (inadequate response to radioactive material spill, one frequency bin reduction due to due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials The IW scenario consequences may increase to ***moderate*** for this event resulting in a Risk Class II scenario for the IW (*unlikely* frequency, ***moderate*** consequences) due to the higher consequences associated with the longer duration exposure Therefore, for this situation, the risk class becomes Risk Class II for the IW due to the failure of the ***radiation protection*** or the ***emergency plan*** mitigative feature concurrent with the spill

In the situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of the drop/fall of stacked waste containers

- ***Filtered Exhaust Ventilation*** (MOI and CW only) For spills in ventilated areas (north waste storage areas), the ***filtered exhaust ventilation*** systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the CW and the MOI

- ***Training*** (IW only) In addition to the preventive features of the ***Training*** program identified above, the IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***LS/DW*** (IW only) Facility management or other personnel can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of a container spill to facility personnel

In summary, the analyzed accident scenario yields Risk Class I results to the CW and Risk Class III results to the MOI and the IW Failures of individual preventive or mitigative features concurrent with the accident do not increase the risk class of the scenario for the MOI or the CW For failure of the ***radiation protection*** or ***emergency plan*** mitigative features, where the response by the IW to the radioactive spill is not correct, the risk class for the IW could increase to Risk Class II depending on the dose received by the IW In all other cases, failure of the individual preventive or mitigative features concurrent with the accident do not increase the scenario IW risk class It is not expected that failures of mitigative features concurrent with the accident will yield MOI doses in excess of 5 rem or CW doses in excess of 25 rem

5.4.3 Spill Scenario 2 - Facility Structural Failure Spill

This accident scenario is discussed below and is summarized in Table 93 located at the end of Section 5.4, *Spill Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A spill is postulated to occur as a result of breaching 55-gallon TRU waste drums containing radioactive material (*Hazard/Energy Source 4B*) The breach of the drums occurs due to damage incurred by the drums when the east-west running hallway (Room 153) located north of Rooms 140/141 structurally fails (*Hazard/Energy Source 13E*) The structural failure of the hallway occurs due to exceeding the load carrying capacity of the hallway floor Upon impact with the hard surface, the drums are damaged and opened, and the waste packages in the drums are breached by the weight of the waste packages and the force of the impact This is considered a confined material release since it is postulated the material is released upon impact and the packaging (drum and polyethylene bag) will contain some of the material from being released to the atmosphere

The TRU waste drums will be stacked (2 high) and one-deep along the south wall of the hallway Approximately 104 drums may be stored in this area

Scenario Modeling Assumptions spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The evaluated scenario frequency is *unlikely* since structural failures of buildings are considered *unlikely* events The evaluated scenario assumes that the waste containers brought into the complex meet ***metal waste container*** specifications, therefore, actual breaches of the containers due to structural impact are reduced due to the strength of the container

The hallway floor loading capacity of Building 991 was evaluated in calculation CALC-991-BS-000025 (Ref 37) and verified to have the strength to support radioactive waste drums stacked two (2) high at one side of the hallway and a forklift running parallel or perpendicular to the hallway The forklift load that was analyzed was larger than the existing forklift now in use This allows the use of a larger forklift in the future should the need arise without updating the analysis A maximum radioactive waste drum load of 800 pounds was assumed in the calculation

Based upon the above *unlikely* scenario that drums and operations in the hallway will exceed the floor loading capacity of the hallway, the frequency of this scenario occurring can be reduced to *extremely unlikely*

Scenario Modeling Assumptions *extremely unlikely* event

Material-At-Risk

The evaluated MAR for this scenario is the total inventory of TRU waste containers that may be stored in the hallway, which is estimated at approximately 100 drums Assuming each drum contains the maximum ***container radioactive material loading*** (*i e*, 200 grams WG Pu equivalent), then the total MAR would be 20,000 grams

The number of waste containers that could potentially be involved in the accident could be the total inventory in the hallway (*i e*, approximately 100 drums) This is considered a conservative assumption since the drums stored in the hallway will be separated in groupings of drums so as not to block doorways and other openings Assuming that all 100 drums are in one location is a conservative assumption It is also considered conservative to assume that a total collapse of the floor occurs if the floor loading requirements are exceeded A more likely scenario would be that there is localized structural failure of the floor resulting in floor sagging and cracking but not total collapse of the floor In the more likely scenario, none of the waste containers stored in the hallway would be breached Therefore, there would be no MAR Assuming the worst case, the total number of drums that are involved in the accident is estimated to be the total inventory of drums in the hallway Of the total number of drums involved in the accident, it is conservatively assumed that 10% of these drums are damaged and breached to a point where a radioactive material release can occur If a container is breached, it is assumed that 100% of the radioactive material in the container is available for release Therefore, based upon these assumptions, the analyzed MAR for this scenario is 2,000 grams (100 drums x 200 grams/drum x 10% DR x 100% material available for release) A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y

Scenario Modeling Assumptions 100 drums, 20,000 grams, blended DCF, DR = 0 1

Accident Consequences

The radiological dose consequences of facility collapse induced spills involving TRU waste containers were originally assessed to be *high* for both the MOI and CW since the evaluated MAR was greater than 157 grams (WG Pu equivalent) This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, ***high*** consequences) Based on Table 2, the radiological dose consequences of unmitigated spills were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequences)

The analyzed radiological dose consequences of the facility collapse induced spill involving ten 55-gallon TRU waste drums are *moderate* (0 17 rem) to the MOI and *moderate* (24 rem) to the CW The resulting risk classes for the scenario are Risk Class III for both the MOI and the CW (*extremely unlikely* frequency, *moderate* consequences)

For the IW located in the vicinity at the time of the event, a floor collapse could cause serious injury to those standing on the floor at the time of the collapse The radiological dose consequences to the IW that is in the vicinity, but not incapacitated, by the failed floor are qualitatively judged to be *low*, consistent with Table 2 for mitigated spills, due to (1) the indicators of the event (*i e*, floor cracking or sagging prior to total floor collapse) that informs the IW of the event, and (2) the building ***emergency plan*** and ***radiation protection*** guidance that directs the IW to evacuate The resulting risk class for this scenario is Risk Class IV to the IW (*extremely unlikely* frequency, *low* consequences)

The IW located in the facility but away from the accident will not be exposed to the floor collapse event (no injury potential) but could be exposed to a radiological release from the breached waste containers There are no systems in the facility that will provide warning to the IW in the facility but away from the accident However, if personnel are in the vicinity and are not incapacitated, they will be able to make an announcement over the ***LS/DW system*** leading to evacuation, per the facility ***emergency plan***, of any facility IW unaware of the event It is also expected that the event (total collapse of the floor) would damage the sprinkler lines attached to the ceiling of the utility tunnel If this occurs a ***flow alarm*** and ***water gong*** would be initiated that would provide another means of notifying the initially unaware IW If a ***LS/DW system*** announcement, ***flow alarm***, and/or ***water gong*** is initiated, it is expected that the initially unaware IW will evacuate the building in accordance with the building ***emergency plan*** No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

The postulated spill due to structural failure of the hallway floor in the Building 991 Complex is considered to be an *extremely unlikely* event with *moderate* consequences to the MOI and CW, and an *extremely unlikely* event with *low* consequences to the IW The risk classes for the MOI and the CW are Risk Class III, which is considered to be acceptable The risk class for the IW is Risk Class IV, which is also considered to be acceptable

One preventive feature has been credited in the determination of scenario frequency and three mitigative features have been credited in determination of scenario consequences

The credited preventive feature is

the Administrative Control for ***metal waste container*** specifications (all receptors)The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors),

2 the Administrative Control for ***radiation protection*** (IW only), and

3 the Administrative Control for ***emergency plan*** (IW only)

Failure of the ***metal waste container*** preventive feature (inadequate container, one frequency bin reduction) would increase the likelihood that a waste container breach could occur due to a facility structural failure event Since the scenario was determined to be an *extremely unlikely* event, failure of the ***metal waste container*** preventive feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failure of the ***container radioactive material loading*** mitigative feature (underestimation of existing container inventory, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take over 29 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (0 17 rem to 5 rem) and 1 04 times the MAR to change the CW dose consequence bin assignment (24 rem to 25 rem) This equates to an average TRU drum inventory of over 208 grams in each of the 10 drums breached following the floor collapse This inventory error is possible for one or two drums but is *unlikely* for 10 specific drums involved in the spill event Since the scenario was determined to be an *extremely unlikely* event, failure of the ***container radioactive material loading*** mitigative feature in 10 specific drums concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***radiation protection*** or the ***emergency plan*** mitigative features (inadequate response to radioactive material spill, one frequency bin reduction due to due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials Since the scenario was determined to be an *extremely unlikely* event, failure of the ***radiation protection*** or ***emergency plan*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

In the situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood that stacked waste containers in the hallway exceed the floor loading capacity

- ***Filtered Exhaust Ventilation*** (MOI and CW only) For spills in ventilated areas (north waste storage areas), the ***filtered exhaust ventilation*** systems of the facility can aid in scenario mitigation by filtering exhaust and reducing the radiological dose consequences of the CW and the MOI

- ***Training*** (IW only) In addition to the preventive features of the ***Training*** program identified above, the IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***LS/DW*** (IW only) Facility management or other personnel can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of the floor collapse and subsequent radioactive material spill to facility personnel

- ***Flow Alarm/LS/DW*** (IW only) The ***flow alarm*** of the automatic suppression system could be initiated due to damage to the sprinkler system piping from the floor collapse that would notify the Fire Dispatch Center of the event Once informed by the ***Fire Department***, facility management can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of an event requiring evacuation

- ***Water Gong Alarm*** (IW only) ***Water gong alarm*** activation following breach of the fire suppression system piping from the floor collapse may reduce IW consequences by providing indication of the event to some facility personnel

In summary, the analyzed accident scenario yields Risk Class III results to the MOI and the CW and Risk Class IV results to the IW Failures of individual preventive or mitigative features concurrent with the accident do not increase the risk class of the scenario for any receptor It is not expected that failures of mitigative features concurrent with the accident will yield MOI doses in excess of 5 rem

5.4 4 Spill Scenario Assumptions, Features, Requirements

In the evaluation of the spill scenarios, assumptions, protective features, and requirements were identified for prevention and/or mitigation of the accidents This information is found in Section 4 3 6 3, *Bounding Spill Scenarios Determination*, and in Section 5 4, *Spill Scenario Accident Analyses* Table 91 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of spill

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scenarios The scenarios to which each assumption, feature, or requirements applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 91 Assumptions/Features/Requirements for Spill Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G2	LLW containers contain no more than 0 5 grams (WG Pu equivalent) in metal drums and 3 grams in wooden or metal boxes	Spill Scenario 1	Sets the potential MAR for the scenario impacting LLW containers ***Container Radioactive Material Loading***
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Spill Scenario 1 Spill Scenario 2	Sets the potential MAR for the scenario impacting TRU waste containers ***Container Radioactive Material Loading***
G5	A pallet of TRU waste drums contains no more than 4 drums	Spill Scenario 1	Sets the potential MAR for the scenario
A1	The CHEM, CON, GEN, MAINT, and SURV activities require a very limited amount of container movements	Spill Scenario 1	Reduces the likelihood of some direct interaction scenarios dealing with container movements by one frequency bin
A3	Damaging tunnel failure and floor loading failures are *unlikely* events	Spill Scenario 1 Spill Scenario 2	Sets the likelihood of some internal and external events
A6	The CHEM, CON, GEN, MAINT, RA, and SURV activities perform limited operations with material handling equipment	Spill Scenario 1	Reduces the likelihood of some indirect interaction scenarios dealing with material handling equipment impacts on other activity containers by one frequency bin
A19	A drop/fall of banded waste drums results in the equivalent release of material of one waste container	Spill Scenario 1	Sets the potential MAR for the scenario impacting banded waste drums ***Banding***
A20	The floor loading capacity of the hallways is adequate to handle the expected loads	Spill Scenario 2	Reduces the frequency of the scenario dealing with overloading the hallway floor to *Extremely Unlikely*

Table 91 Assumptions/Features/Requirements for Spill Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F3	Metal waste containers are *unlikely* to be breached by non-forklift tine impacts from material handling equipment expected during operation	Spill Scenario 1 Spill Scenario 2	Reduces the likelihood of metal waste container failure from scenarios dealing with dropped containers by one frequency bin ***Metal Waste Container***
F28	Metal waste containers cannot be breached by falls less than four feet	Spill Scenario 1	Reduces the likelihood of metal waste container failure due to dropping from less than four feet to *Beyond Extremely Unlikely* ***Metal Waste Container***
R1	Stacking of Type B shipping containers is prohibited	Spill Scenario 1	Reduces the likelihood of Type B shipping container spills associated with stack toppling to *Beyond Extremely Unlikely*
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	Spill Scenario 1 Spill Scenario 2	Reduces the exposure to the IW to releases ***Emergency Plan***
R19	Storage of waste containers in Corridor C is prohibited	Spill Scenario 2	Eliminated analysis of structural failure of the corridor and its potential impact on the MOI, CW, and IW ***Storage of Waste Containers in Corridor C Prohibited***
R20	Waste containers stacked above the second tier will be banded	Spill Scenario 1	Reduces the effective MAR of the scenario due to a pallet of TRU waste container dropping or falling from the third or fourth tier of the stack ***Banding***
R21	The Building 991 Complex will comply with Radiation Protection program guidance	Spill Scenario 1 Spill Scenario 2	Reduces the exposure to the IW to releases ***Radiation Protection***

Table 92 Spill Scenario 1 - TRU Waste Drums Drop/Fall

Hazard	4B (Radioactive Materials/Waste Container)
Accident Type	Spill involving a pallet of 55-gallon TRU waste drums, spill occurs during pallet movement Effective MAR = 200 grams of aged WG Pu (25% damage ratio), accident can occur anywhere in the complex where waste containers are stacked above a second tier
Cause or Energy Source	[energy sources] 7A (Vehicles, Material Handling Equipment), 8B (Raised Loads on Forklifts), and 8C (Stacked Waste Containers)
Applicable Activity(ies)	[most likely] WASTE, [less likely] CHEM, CON, GEN, MAINT, RA, SNM, and SURV

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
MOI	Anticipated	Anticipated	High	Low 0 023 rem	I	III	<u>Metal Waste Container</u> [F3/F28] Container <u>Rad</u> Material Loading [G4] Banding [<u>A19</u>/R20] Training Filtered Exhaust Ventilation	C C C D D	P M M P M	AC 5 2 AC 5 2 AC 5 2 TRAIN AC 5 5
CW	Anticipated	Anticipated	High	Moderate 3 1 rem	I	I	Same as MOI			
IW	Anticipated	Anticipated	<u>Moderate</u>	Low	<u>I</u>	III	<u>Metal Waste Container</u> [F3/F28] Container <u>Rad</u> Material Loading [G4] Emergency Plan [R12] Radiation Protection [R21] Banding [R20] Training LS/DW	C C C C C D D	P M M M M P/M M	AC 5 2 AC 5 2 AC 5 6 RAD AC 5 2 TRAIN AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

Table 93 Spill Scenario 2 - Facility Structural Failure Spill

Hazard	4B (Radioactive Materials/Waste Container)
Accident Type	Spill involving TRU waste drums stacked on floor above basement utility tunnel, spill occurs during storage Effective MAR = 2,000 grams of aged WG Pu (10% damage ratio), accident occurs in Room 153, east to west hallway in north waste storage area
Cause or Energy Source	[cause] structural failure of floor due to overloading [energy sources] 13E (Floor Loading)
Applicable Activity(ies)	[most likely] WASTE, [less likely] CHEM, CON, GEN, MAINT, RA, SNM, and SURV

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation	With Prevention/ Mitigation				
MOI	Unlikely	Extremely Unlikely	High	Moderate 0 17 rem	I	III	<u>Metal Waste Container</u> [F3] Container <u>Rad</u> Material Loading [G4] Training Filtered Exhaust Ventilation	C C D D	P M P M	AC 5 2 AC 5 2 TRAIN AC 5 5
CW	Unlikely	Extremely Unlikely	High	Moderate 24 rem	I	III	Same as MOI			
IW	Unlikely	Extremely Unlikely	<u>Moderate</u>	Low	<u>II</u>	IV	<u>Metal Waste Container</u> [F3] Container <u>Rad</u> Material Loading [G4] Emergency Plan [R12] Radiation Protection [R21] Training LS/DW Flow Alarm/LS/DW Water Gong Alarm	C C C C D D D D	P M M M P/M M M M	AC 5 2 AC 5 2 AC 5 6 RAD TRAIN AC 5 5 AC 5 5 AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

5 5 PUNCTURE SCENARIO ACCIDENT ANALYSES

5 5.1 Puncture Scenario Development and Selection

Two bounding puncture scenarios were identified in Section 4 3 6 4, *Bounding Puncture Scenarios Determination* The first puncture scenario, B-PUNCT-1, involves the *anticipated* puncture of a single LLW container (wooden LLW crate), the *unlikely* puncture of a single TRU waste container or a single pallet of TRU waste containers, and the *extremely unlikely* puncture of a single container (for each of Type B shipping and POC containers) The second puncture scenario, B-PUNCT-2, involves the *unlikely* puncture of an entire room or area of waste containers resulting from facility structural failures (for each of LLW and TRU waste containers), and involving the *extremely unlikely* puncture of an entire room or area of POC containers resulting from facility structural failures

B-PUNCT-1 involves the puncture of a LLW, TRU, POC, or Type B shipping container due to a forklift tine accident The POC container puncture possibility is based on a finite element analysis evaluating the susceptibility of the container to punctures by forklift tines or by falling heavy objects, according to NSTR-001-97 (Ref 38) The POC puncture possibility was carried over to a Type B shipping container possibility due to a similarity in the robustness of the containers

The finite element analysis modeled the impact of a 12,250 lb forklift traveling at 10 mph against a POC Actual forklifts currently used in Building 991 weigh between 1/3rd and1/4th of the analyzed weight and do not travel at speeds anywhere near 10 mph in the facility The forklift tine was modeled very conservatively, having a squared-off end with sharp corners and being made of an extremely dense material Actual forklift tines have blunt ends without sharp corners and are made of steel with a density about the same as that of the drum material The forklift tine was modeled impacting a POC that is lodged against a rigid wall (*i e*, container can not move at impact) and the impact was modeled as being a dead-center impact of the tine with the pipe component in the POC container Actual POC and Type B containers are rarely in a configuration where they cannot move and forklift tine levels are rarely at a dead-center level with POC container internal pipe components when the tines approach a pallet of containers for movement

The results of the finite element analysis indicated that a 12-inch pipe component in a POC container is able to stop the modeled tine and cause it to rebound but the pipe component suffers minor tearing at the corners of the tine (realistic tines are not expected to tear the pipe component since sharp corners on the tine do not exist) The 6-inch pipe component also stopped the modeled tine but the tine was able to penetrate the pipe component An analysis of an off-center tine impact on a 6-inch pipe component did not result in tearing of the pipe component but pushed the pipe component off to the side in the packing material

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The likelihood of a forklift tine punctures of POC and Type B containers were initially considered to be *extremely unlikely* events

- Feature F11 indicates that the breach of ***Type B shipping containers*** by forklift tine impacts must be *extremely unlikely* events due to impact angle requirements needed to lead to failure and due to SNM packaging

- Feature F12 indicates that the breach of ***POC containers*** by forklift tine impacts must be *extremely unlikely* events due to impact angle requrements needed to lead to failure and due to pipe component packaging

The low likelihood of the puncture events primarily focused on the likelihood of achieving the required configuration (*i e* , container against a rigid object, tine at correct height, tine at pipe component center laterally) and crediting the container robustness There was no consideration of the forklift mass, speed, and usage in the initially frequency bin assignment In addition, there was no consideration of forklift tine shape Forklift tines with tapered ends and sharp corners are needed to yield the damage assessed in the finite element analysis Forklift tines in use in Building 991 are blunted or rounded to aid in engaging pallets It is considered to be a less likely event (possibly *beyond extremely unlikely* event) that a blunted or rounded forklift tine will be able to align with the pipe component to yield a puncture Rounded forklift tines will tend to move the pipe component and the forklift tine laterally This may yield scoring of the pipe component but should not yield a puncture based on the assessment of an off-center tine impact (tine edge 0 5 inches off center) on the 6-inch pipe component discussed above

As stated above, forklifts used in Building 991 are a factor of 3 to 4 lower in mass than the finite element analyzed forklift The lower forklift mass would reduce the impact of a forklift tine impact, probably failing to tear a 12-inch pipe component and providing less tear damage, if any, to a 6-inch pipe component Also, as a forklift approaches pallets of containers (providing opportunity for puncture), the speed of the forklift is much less than 10 mph with the corresponding reduction in container damage potential

Forklifts may travel at speeds near 10 mph during unloaded movements and could go off course However, in this situation, the tines being oriented appropriately to yield a puncture event is considered to be a *beyond extremely unlikely* event Along with consideration of the original likelihood of achieving the required configuration, this is based on the following 1) forklifts intentionally traveling at higher speeds are aimed down major aisles or corridors, 2) it is unlikely that there would be containers against a wall at the end of a major aisle or corridor (generally off to the sides of aisles or corridors), 3) forklifts veering off course would impact containers that are not against rigid objects (*i e* , would impact the sides of stacks), and 4) forklifts traveling at higher speeds would generally have the tines at a lower level than drum center

Forklifts lining up to lift loads may inadvertently travel at higher speeds due to operator error However, in this situation, the tines being oriented appropriately to yield a puncture event is also considered to be a *beyond extremely unlikely* event Along with consideration of the original likelihood of achieving the required configuration, this is based on the following 1) forklifts do not intentionally travel at higher speeds when lining up for a lift, 2) the distance available for the forklift to accelerate to higher speeds is limited (*i e*, stacks lined up in a manner to present a rigid object behind the first pallet require forklift turning off the aisle or corridor to pick up a pallet), and 3) forklifts lining up for lifts will have the tines at a lower level than drum center

In the case of Type B shipping containers, the configuration most likely to present a container with a rigid object (*e g*, wall) behind the container is found in the vault Forklifts are seldom used in container transfers from vaults, handcarts are generally used due to the limited area in the vault to operate a lifting device Even if a forklift is used in the vault, the forklift would be unable to accelerate to higher speeds to pick up containers due to the limited space available and the need for turns to pick up any pallets Containers being removed from a transport vehicle are not generally in a configuration with containers up against rigid objects Therefore, the likelihood of a Type B shipping container being in the correct configuration for a forklift tine puncture is considered to be a *beyond extremely unlikely* event

For the above reasons, the punctures of POC containers or Type B shipping containers are considered to be *beyond extremely unlikely* events Scenario consequences from a puncture will be evaluated for information purposes but risk class determinations will not be performed due to the accident likelihood The puncture scenario, derived from B-PUNCT-1, to be further analyzed is

> **Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures:** This puncture scenarios involve the contents of either a LLW, TRU, POC, or Type B container LLW and TRU waste containers are assumed to be breached during movement operations due to a forklift tine puncture of the container The punctures of POC and Type B containers will be evaluated to determine potential consequences but are not considered to be credible accident scenarios The wooden LLW crate puncture can occur in the West Dock Canopy Area (at the time of lifting for removal from storage or placing into storage) and the TRU waste container punctures can occur in all storage areas (at the time of removing or placing into storage) or at the west or east dock (at the time of lifting for receipt of the container or following a material handling vehicle transfer of the container prior to loading onto a transport vehicle)

Further analysis of B-PUNCT-2 is required B-PUNCT-2 involves TRU or POC containers being breached due to structural failure of the hallway where the waste containers are stored This scenario is expected to yield similar results to Spill Scenario 2 as discussed in Section 5 4 3, *Spill Scenario 2 - Facility Structural Failure Spill* Therefore, the controls specified in Spill Scenario 2 are considered applicable to this scenario and no further analysis of B-PUNCT-2 is required for the following reasons

1 For LLW and TRU waste containers the primary difference between the spill and puncture scenarios is that in the spill scenario the drums will be damaged due to structural failure of the floor, some of the damaged drums will be breached, and a

"confined material release" will occur from the breached drums In the puncture scenario the drums will be damaged due to the structural failure of the floor, some of the damaged drums will be punctured by sharp edges of the concrete or from the reinforcement bar in the concrete, and an "unconfined material release" will occur from the punctured drums The assumption is made that the number of drums breached in the spill scenario and the number of drums punctured in the puncture scenario will be the same

To determine the bounding scenario to analyze (*i e*, spill or puncture), the initial respirable source term for each of the scenarios can be analyzed The initial respirable source term is determined by multiplying the expected MAR for the containers that may be involved in the incident by the DR, by the ARF, and by the RF Table 94 shows the initial respirable source term based upon a spill or puncture of one container is the same

Therefore, since the number of drums involved in the event is the same, the initial respirable source term is the same, the frequency (*extremely unlikely*) is the same, and the controls will be the same (both spills and punctures can be considered spills), further analysis of the puncture scenario for LLW and TRU waste containers is not necessary

Table 94 Initial Respirable Source Term Spill and Puncture Scenarios

RELEASE MECHANISM CONTAINER TYPE	EXPECTED MAR (g)[1]	DR	ARF	RF	INITIAL RESPIRABLE SOURCE TERM (g)
Spill Scenario TRU 55-gallon drum	200	1 0	1 0E-03[3]	1 0E-01[3]	0 02
Puncture Scenario TRU 55-gallon drum	200	0 1[2]	1 0E-03[3]	1 0[3]	0 02

1 Container fissile material loading as per Table 16
2 Reference NSTR-001-97
3 Reference SARAH, Table 6-1

2 In the spill scenario it was determined that breaching of the POC due to a drop/fall event could be considered a *beyond extremely unlikely* event since the POC containers had been shown to withstand 30 foot drops and that structural failure of the hallway floor would result in a drop of approximately 10 feet Further analysis of the POC containers in the spill scenario involving structural failure of the hallway floor was considered to be unnecessary In Spill Scenario 2, it was also determined that the scenario frequency was considered to be an *extremely unlikely* event due to the *unlikely* frequency that a ***metal waste container*** will be damaged plus the *unlikely* frequency that the floor will collapse from overloading due to the loading the floor can withstand and the weights of containers at the Site Assuming the container weights for POC containers is equivalent to the weights of the TRU waste and LLW

drums (POC containers will most likely have a net weight much less than these containers since they are not as densely packed and would have an increase in tare weight), it can be assumed that the frequency of a floor collapse due to overloading the floor with POC containers is also an *unlikely* event The ***POC containers*** are more resistant to damage than the metal waste containers and it is considered an *extremely unlikely* event that they will be damaged during a structural failure of the hallway floor Therefore, based upon the *unlikely* frequency of the floor collapse and the *extremely unlikely* frequency of POC damage, the likelihood of a POC puncture due to collapse of the hallway floor is considered a ***beyond extremely unlikely*** event and no further analysis is required

In addition, per NSTR-001-97 (Ref 38), it is indicated that the POC is only susceptible to damage from an edge impact of a concrete slab onto the side of a horizontal POC In order to breach a horizontal POC the fall speed would have to exceed 9 5 m/s The estimated fall speed for a collapse of the hallway floor (approximately 10 feet (3 meters) high) is 7 7 m/s, which is less than the fall speed required to breach the container

5.5.2 Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures

This accident scenario is discussed below and is summarized in Table 96 located at the end of Section 5 5, *Puncture Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A radioactive material (*Hazard/Energy Source 4A* or *Hazard/Energy Source 4B*) spill is postulated to occur as a result of puncturing a LLW or TRU waste container Consequences for a postulated puncture of POC or Type B shipping containers will be determined although the event is considered to be *beyond extremely unlikely* The puncture of the container may occur as a result of the container being impacted and punctured by material handling equipment (*Hazard/Energy Source 7A*) while loading, unloading, and/or transferring the container from its receipt/shipment area to its storage/staging area. The puncture may occur in all storage/staging areas in the building as well as the dock areas during receipt/shipment operations The forklift error results in a puncture, by the forklift tines, of either one wooden LLW crate, one TRUPACT II SWB, one metal box, one TRU waste container, or two adjacent drums (LLW or TRU waste) located on a pallet One POC container or one Type B shipping container is evaluated as being punctured A fraction of the contents of the punctured waste container(s) is postulated to "flow" through the breach onto the ground/floor Therefore, this puncture induced spill is analyzed as a contaminated unconfined material release (for LLW and TRU waste containers) In accordance with NSTR-001-97 and technical direction from the DOE, for POC containers, the recommended values to use for the ARF and RF are 2E-03 and 1E-02, respectively For the Type B shipping container the puncture induced spill is analyzed as powder using the RADIDOSE default ARF and RF values A ground-level (non-lofted) release of the

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radioactive material is assumed The spill from the puncture is a short duration event and a minimum release (10 minutes) is analyzed

Four cases will be evaluated for this scenario

1 Case A involves the puncture of a wooden LLW crate,

2 Case B involves the puncture of two adjacent TRU waste drums on a pallet [bounding scenario for TRU waste containers due to the MAR involved (400 grams for two TRU waste drums versus 320 grams for a TRUPACT II SWB or metal waste box and 200 grams for a single TRU waste drum), the ARF, RF, DR, and frequency of occurrence are the same for each of the TRU waste containers, therefore the potential MAR involved in the event is the deciding factor],

3 Case C involves the POC container, and

4 Case D involves the Type B shipping container

Scenario Modeling Assumptions

Case A and Case B - spill due to puncture, unconfined material,10 minute duration, non-lofted plume

Case C - spill due to puncture, ARF of 2E-03, RF of 1E-02, 10 minute duration, non-lofted plume

Case D – spill due to puncture, powder, 10 minute duration, non-lofted plume

Accident Frequency

The evaluated accident scenario is considered to be an *anticipated* event for Case A, an *unlikely* event for Case B, and a *beyond extremely unlikely* event for Case C and Case D The likelihood of this scenario for the different cases is defined by a condition or assumption made in the analysis

- Feature F10 indicates that ***metal waste container*** punctures by forklift tines are considered to be *unlikely* events due to container resistance and impact angle requirements

- Feature F11 indicates that ***Type B shipping container*** punctures by forklift tines are considered to be *extremely unlikely* events due to container resistance and impact angle requirements

- Feature F12 indicates that ***POC container*** punctures by forklift tines are considered to be *extremely unlikely* events due to container resistance and impact angle requirements

Additional considerations beyond the ***Type B shipping container*** and ***POC container*** features result in punctures of these containers being *beyond extremely unlikely* events, as discussed above

Scenario Modeling Assumptions Case A - *anticipated* event, Case B - *unlikely* event, Case C and Case D – *beyond extremely unlikely* events

Material-At-Risk

The evaluated scenarios assumed that in Case A only a single wooden LLW crate was involved in the container puncture event Based on General Assumption G2, no more than 3 grams (WG Pu equivalent) will be in a wooden LLW crate For Case B, two adjacent TRU drums are involved in the container puncture event Based on General Assumption G4 and General Assumption G5, no more than 200 grams (WG Pu equivalent) will be in a TRU waste drum and two drums can be impacted by forklift tines for palletized drums For Case C, one POC container is considered to be involved in the container puncture event Based on General Assumption G6 and General Assumption G7, no more than 1,255 grams (WG Pu equivalent) will be in a POC container and only one POC container on a pallet will be impacted by a forklift tine puncture For Case D, only a single Type B shipping container is involved in the container puncture event Based on General Assumption G9, Type B containers are assumed to contain no more than 6,000 grams (WG Pu equivalent) of oxide Solubility Class W is conservatively assumed for the LLW, TRU, and POCs involved in the puncture event Solubility Class Y is assumed for the Type B shipping container that is punctured

For a puncture of either a wooden LLW crate or a TRU drum, it is assumed that 10% of the material in the waste container is available for release A material release from a puncture is evaluated as an unconfined material release (*i e*, ARF of 1 0E-03, RF of 1 0E+00) These material release factors are considered conservative assumptions based on the multiple layers of plastic bags that would have to be damaged in order to release any of the contents and the fact that a forklift tine would create a relatively small sized hole through these barriers This 10% DR also accounts for potential differences in packaging of the containers (*i e*, some containers may not be packaged with rigid interior liners)

The potential DR for POC containers is discussed in NSTR-001-97_ If an interior package is punctured, it is assumed that the POC topples over after the tine is removed, that the puncture hole is oriented downward, and that the material pours out of the hole as if it is a fine powder Since the number of interior packages cannot be absolutely determined, it is assumed that the POC contains only one interior package Based upon these assumptions the DR for a puncture of a POC is conservatively estimated as 1 0 The NSTR also recommends that an ARF of 2E-03 and a RF of 1E-02 (per DOE direction) be used for a puncture of a POC For the Type B shipping container it is assumed that the DR is 1 0 and that the default values specified in RADIDOSE for the AFR and RF are appropriate (i e , ARF of 2 0E-03 and RF of 3 0E-01)

Another consideration in the evaluation of POC punctures is the solubility class of the radioactive material The 1,255 grams (WG Pu equivalent) is derived from an assumption of 16 grams of americium and 199 grams of plutonium A multiplier of 66 based on the ratio of the

DCF for americium to the DCF for Solubility Class Y WG Pu, is applied to the americium and that is added to the plutonium content yielding a value of 1,255 grams, WG Pu equivalent for Solubility Class Y material If the material is Solubility Class W, a more appropriate multiplier is 42 76 yielding a value of 883 grams, WG Pu equivalent for Solubility Class W material Evaluating Solubility Class W POC material using the 1,255 grams (WG Pu equivalent) value is overly conservative It is more conservative (*i e*, yields about 9% higher consequences) to evaluate a situation using 883 grams of Solubility Class W material versus using 1,255 grams of Solubility Class Y material in a POC Given that there are no restrictions dealing with solubility class for POC material, a Solubility Class W assumption will be made to cover all situations

Scenario Modeling Assumptions

Case A - 1 crate, 3 grams, aged WG Pu, Solubility Class W, DR = 0 1

Case B - 2 drums, 400 grams, aged WG Pu, Solubility Class W, DR = 0 1

Case C - 1 POC container, 883 grams, WG Pu, Solubility Class W, DR = 1 0

Case D - 1 Type B shipping container, 6,000 grams, aged WG Pu, Solubility Class Y, DR = 1 0

Accident Consequences

The radiological dose consequences of punctures involving LLW containers (*i e*, Case A) were originally assessed to be *low* for both the MOI and the CW. This yielded an initial risk class for the scenario of Risk Class III for both receptors (*anticipated* frequency, *low* consequences) The radiological dose consequences of punctures involving TRU waste containers (*i e*, Case B) were originally assessed to be ***high*** for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequences) The radiological dose consequences of punctures involving POC containers (*i e*, Case C) and Type B shipping containers (*i e*, Case D) were originally assessed to be ***high*** for both the MOI and the CW This yielded initial risk classes for the scenarios of Risk Class II for both receptors (*extremely unlikely* frequency, *high* consequences) Based on Table 2, the radiological dose consequences of unmitigated spills were originally assessed to be *moderate* for the IW This yielded initial risk classes for the scenarios of Risk Class I for the IW in Case A (*anticipated* frequency, *moderate* consequence), of Risk Class II for the IW in Case B (*unlikely* frequency, *moderate* consequence), and of Risk Class III for the IW in Cases C and D (*extremely unlikely* frequency, *moderate* consequence)

Case A The analyzed radiological dose consequences for LLW container punctures, based on the effective MAR as discussed above, are *low* (3 4E-04 rem) for the MOI and *low* (0 047 rem) for the CW The resulting risk classes for the scenario are Risk Class III for both the MOI and the CW (*anticipated* frequency, *low* consequences)

Case B The analyzed radiological dose consequences for TRU waste container punctures, based on the effective MAR as discussed above, are *low* (0 046 rem) for the MOI and *moderate* (6 2 rem) for the CW The resulting risk class for the scenario is Risk Class III for the

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MOI (*unlikely* frequency, *low* consequences) and Risk Class II for the CW (*unlikely* frequency, *moderate* consequences)

Case C The analyzed radiological dose consequences for POC container punctures, based on the effective MAR as discussed above, are *low* (0 020 rem) for the MOI and *moderate* (2 7 rem) for the CW The scenario is considered to be a *beyond extremely unlikely* event

Case D The analyzed radiological dose consequences for Type B shipping container punctures, based on the effective MAR as discussed above, are *moderate* (2.9 rem) for the MOI and *high* (390 0 rem) for the CW The scenario is considered to be a *beyond extremely unlikely* event

For the IW located in the vicinity at the time of the event, the puncture event could hypothetically cause serious injury to those either driving the forklift or standing near the containers The radiological dose consequences of the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated spills, due to (1) the limited radiological material that is released due to ***container radioactive material loading*** limits, (2) the indicators of an accident (*i e*, toppled drums, noise) that informs the IW of the event, and (3) the building ***emergency plan*** and ***radiation protection*** guidance that directs the IW to evacuate These controls mitigate the consequences of the event to the IW The resulting risk class for Case A is Risk Class III to the IW (*anticipated* frequency, *low* consequences), for Case B is Risk Class III to the IW (*unlikely* frequency, *low* consequences), and Case C and Case D are considered to be *beyond extremely unlikely* events

The IW located in the facility but away from the accident will not be exposed to the container puncture event (no injury potential) but could be exposed to a radiological release from the breached containers There are no systems in the facility that will provide warning to the IW in the facility but away from the accident However, the mechanisms that are identified for initiation of this event deal with the movement of containers by material handling equipment that requires personnel participation. These personnel, unless incapacitated, will be able to make an announcement over the ***LS/DW system*** leading to evacuation, per the facility ***emergency plan***, of any facility IW unaware of the event The consequences for the initially unaware IW are qualitatively judged to be *low* due to (1) the limited radiological material that is released due to ***container radioactive material loading*** limits, (2) the potential for announcements (*i e*, ***LS/DW***) that informs the IW of the event, and (3) the building ***emergency plan*** that directs the IW to evacuate No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

Three preventive features have been credited in the determination of scenario frequency and three mitigative features have been credited in determination of scenario consequences The credited preventive features are

1 the Administrative Control for ***metal waste container*** specifications (all receptors),

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2 the Administrative Control for ***Type B shipping container*** specifications (all receptors), and

3 the Administrative Control for ***POC container*** specifications (all receptors)

The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors),

2 the Administrative Control for ***radiation protection*** (IW only), and

3 the Administrative Control for ***emergency plan*** (IW only)

Failures of the ***metal waste container*** preventive feature (inadequate container/packaging combination, one frequency bin reduction) could result in some forklift tine-induced container puncture events (related to F10) becoming *anticipated* events The accident scenario likelihood corresponding to these situations is as follows (note assumptions, features, or requirements that are shown with a line through the code indicate the failed protective feature).

- *unlikely* scenario mechanism F10[U] becomes ~~F10~~[A] & feature failure[U] yielding an *unlikely* event

Therefore, there is no change in scenario risk class for Case B due to a failure of the ***metal waste container*** preventive feature

Failure of the ***container radioactive material loading*** mitigative feature (underestimation of existing container inventory, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR For Case A it would take over 294 times the MAR to be involved in the accident scenario to yield a change in the MOI dose consequence bin assignment (from 3 4E-04 rem to 0 1 rem) and over 10 times the MAR to change the CW dose consequence bin assignment (from 0 047 rem to 0 5 rem) This equates to a LLW crate inventory of over 30 grams For Case B it would take over 2 1 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 046 rem to 0 1 rem) and over 4 times the MAR to change the CW dose consequence bin assignment (from 6 2 rem to 25 rem) This equates to an average TRU waste drum inventory of over 420 grams in each of the two drums For Case C it would take 5 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 0 02 rem to 0 1 rem) and over 9 times the MAR to change the CW dose consequence bin assignment (from 2 7 rem to 25 rem) This equates to a POC container inventory of over 4,415 grams (WG Pu equivalent) Therefore, for this situation, there is no change in scenario risk class for Cases A and B due to failure of the ***container radioactive material loading*** mitigative feature

For Case D it takes 1 7 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 2 9 rem to 5 0 rem) This equates to a Type B shipping container inventory of over 10,400 grams

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Failures of the ***radiation protection*** or the ***emergency plan*** mitigative features (inadequate response to container puncture, one frequency bin reduction due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials The IW scenario consequences are assumed to remain *low* even with failures of these mitigative features resulting in a Risk Class III scenario for the IW (*unlikely* frequency, *low* consequences) for Case A and a Risk Class IV scenario for the IW (*extremely unlikely* frequency, *low* consequences) for Case B Since the scenario was determined to be a beyond *extremely unlikely* event for Case C and Case D, failure of the ***radiation protection*** or ***emergency plan*** mitigative feature concurrent with the scenario does not require further evaluation Therefore, for this situation, the risk class remains the same for Case A (Risk Class III) and in Case B there is a risk class reduction to Risk Class IV for the IW due to the failure of the ***radiation protection*** or the ***emergency plan*** mitigative feature concurrent with the puncture of a LLW crate

In the situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of the puncture of containers

- ***Filtered Exhaust Ventilation*** (MOI and CW only) For punctures in ventilated areas (north waste storage areas), the ***filtered exhaust ventilation*** systems of the facility can aid in scenario mitigation by filtering exhaust and reducing the radiological dose consequences of the CW and the MOI

- ***Training*** (IW only) In addition to the preventive features of the ***Training*** program identified above, the IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***LS/DW*** (IW only) Facility management or other personnel can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of a container puncture to facility personnel

In summary, the analyzed accident scenario yields Risk Class III or Risk Class IV results to all receptors except for the CW in Case B, which yields a Risk Class II result Failures of individual preventive or mitigative features concurrent with the accident do not increase the risk class of the scenario for the MOI or the CW In all cases, failure of the individual preventive or mitigative features concurrent with the accident does not increase the scenario IW risk class It is not expected that failures of mitigative features concurrent with the accident will yield MOI doses in excess of 5 rem or CW doses in excess of 25 rem

5 5 3 Puncture Scenario Assumptions, Features, Requirements

In the evaluation of the puncture scenarios, assumptions, protective features, and requirements were identified for prevention and/or mitigation of the accidents This information is found in Section 4 3 6 4, *Bounding Puncture Scenarios Determination*, and in Section 5 5, *Puncture Scenario Accident Analyses* Table 95 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of puncture scenarios The scenarios to which each assumption, feature, or requirements applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 95 Assumptions/Features/Requirements for Puncture Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G2	LLW containers contain no more than 0 5 grams (WG Pu equivalent) in metal drums and 3 grams in wooden or metal boxes	Puncture Scenario 1	Sets the potential MAR for the scenario impacting LLW containers ***Container Radioactive Material Loading***
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Puncture Scenario 1 Spill Scenario 2	Sets the potential MAR for the scenario impacting TRU waste containers ***Container Radioactive Material Loading***
G5	A pallet of TRU waste drums contains no more than 4 drums and only 2 drums can be impacted by forklift tines	Puncture Scenario 1	Sets the potential MAR for the scenario
G6	POC containers contain no more than 1,255 grams (WG Pu equivalent) and 200 grams (fissile equivalent) in metal drums	Puncture Scenario 1	Sets the potential MAR for the scenario impacting POCs ***Container Radioactive Material Loading***
G7	A pallet of POC drums contains no more than 4 drums and only 1 drum can be impacted by forklift tines	Puncture Scenario 1	Sets the potential MAR for the scenario
G8	Type B containers cannot be impacted by activities other than the SNM and SURV activities due to their storage location and safeguards restrictions	Puncture Scenario 1	Defines the potential interactions and corresponding types of containers for the scenario ***SNM Only Staged in Vaults***

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Table 95 Assumptions/Features/Requirements for Puncture Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G9	Type B containers are assumed to contain no more than 6,000 grams (WG Pu equivalent) or oxide	Puncture Scenario 1	Sets the potential MAR for the scenario impacting Type B shipping containers No control is associated with this assumption since the actual quantity of material in a Type B container may be classified This assumption is consistent with other safety analyses at the Site
A1	The CHEM, CON, GEN, MAINT, and SURV activities require a very limited amount of container movements	Puncture Scenario 1	Reduces the likelihood of some direct interaction scenarios dealing with container movements by one frequency bin
A3	Damaging tunnel failure and floor loading failures are *unlikely* events	Puncture Scenario 1 Spill Scenario 2	Sets the likelihood of some internal and external events
A6	The CHEM, CON, GEN, MAINT, RA, and SURV activities perform limited operations with material handling equipment	Puncture Scenario 1	Reduces the likelihood of some indirect interaction scenarios dealing with material handling equipment impacts on other activity containers by one frequency bin
A20	The floor loading capacity of the hallways is adequate to handle the expected loads	Spill Scenario 2	Reduces the frequency of the scenario dealing with overloading the hallway floor to *Extremely Unlikely*
A21	The number of drums breached due to structural failure of the hallway floor is the same in the spill and puncture scenarios	B-PUNCT-2	Defines the number of drums for the scenario so that one analysis can be used to address both scenarios
F3	Metal waste containers are *unlikely* to be breached by non-forklift tine impacts from material handling equipment expected during operation	Spill Scenario 2	Reduces the likelihood of metal waste container failure from scenarios dealing with dropped containers by one frequency bin ***Metal Waste Container***
F7	POC containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	Spill Scenario 2	Reduces the likelihood of POC container failure scenarios dealing with structural members impacting containers by one frequency bin ***POC Container***

Table 95 Assumptions/Features/Requirements for Puncture Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F10	Metal waste containers are *unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and waste packaging	Puncture Scenario 1	Reduces the likelihood of TRU and low-level waste container failure dealing with forklift tines impacting containers by one frequency bin ***Metal Waste Container***
F11	Type B shipping containers are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and SNM packaging	Puncture Scenario 1	Reduces the likelihood of Type B shipping container failure dealing with forklift tines impacting containers by two frequency bins ***Type B Shipping Container***
F12	POCs are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and SNM packaging	Puncture Scenario 1	Reduces the likelihood of POC failure dealing with forklift tines impacting containers by two frequency bins ***POC Container***
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	Puncture Scenario 1 Spill Scenario 2	Reduces the exposure to the IW to releases ***Emergency Plan***
R19	Storage of waste containers in Corridor C is prohibited	Spill Scenario 2	Eliminated analysis of structural failure of the corridor and its potential impact on the MOI, CW, and IW ***Storage of Waste Containers in Corridor C Prohibited***
R21	The Building 991 Complex will comply with Radiation Protection program guidance	Puncture Scenario 1 Spill Scenario 2	Reduces the exposure to the IW to releases ***Radiation Protection***

Table 96 Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures

Hazard	4A (Radioactive Materials/Category I and II SNM), 4B (Radioactive Materials/Waste Container)
Accident Type	Puncture of wooden LLW crate (Case A), 2 TRU drums (Case B), single POC (Case C), or single Type B (Case D) Effective MAR = 0 3 grams aged WG Pu equivalent (10% damage ratio) (Case A), 40 grams aged WG Pu equivalent (10% damage ratio) (Case B), 1,255 grams WG Pu equivalent [883 grams Class W] (Case C), 6,000 grams aged WG Pu equivalent oxide (Case D), accident can occur in storage areas and receipt/shipment areas
Cause or Energy Source	[causes] 11A (Receipt and Shipment of Waste Containers at the Dock), 11B (Receipt and Shipment of SNM Containers at the Dock) and 11C (Movement of Waste Containers in the Facility), [energy sources] 7A (Vehicles, Material Handling Equipment)
Applicable Activity(ies)	[most likely] SNM and WASTE, [less likely] CHEM, GEN, CON, MAINT, RA, and SURV

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation	With Prevention/ Mitigation				
MOI	Case A Anticipated	Case A Anticipated	Case A Low	Case A Low 3 4E-04 rem	Case A III	Case A III	Metal Waste Container [F10]	C	P	AC 5 2
	Case B Unlikely	Case B Unlikely	Case B High	Case B Low 0 046 rem	Case B I	Case B III	Type B Shipping Container [F11]	C	P	AC 5 2
	Case C Extremely Unlikely	Case C Beyond Extremely Unlikely	Case C High	Case C Low 0 020 rem	Case C II	Case C not applicable	POC Container [F12]	C	P	AC 5 2
	Case D Extremely Unlikely	Case D Beyond Extremely Unlikely	Case D High	Case D Moderate 2 9 rem	Case D II	Case D not applicable	Container Rad Material Loading [G2, G4, G5, G6, G9]	C	M	AC 5 2
							Filtered Exhaust Ventilation	D	M	AC 5 5
							Training	D	P	TRAIN

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Table 96 Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures

Hazard	4A (Radioactive Materials/Category I and II SNM), 4B (Radioactive Materials/Waste Container)
Accident Type	Puncture of wooden LLW crate (Case A), 2 TRU drums (Case B), single POC (Case C), or single Type B (Case D) Effective MAR = 0 3 grams aged WG Pu equivalent (10% damage ratio) (Case A), 40 grams aged WG Pu equivalent (10% damage ratio) (Case B), 1,255 grams WG Pu equivalent [883 grams Class W] (Case C), 6,000 grams aged WG Pu equivalent oxide (Case D), accident can occur in storage areas and receipt/shipment areas
Cause or Energy Source	[causes] 11A (Receipt and Shipment of Waste Containers at the Dock), 11B (Receipt and Shipment of SNM Containers at the Dock) and 11C (Movement of Waste Containers in the Facility), [energy sources] 7A (Vehicles, Material Handling Equipment)
Applicable Activity(ies)	[most likely] SNM and WASTE, [less likely] CHEM, GEN, CON, MAINT, RA, and SURV

Receptor	**Scenario Frequency**		**Scenario Consequence**		**Scenario Risk Class**		**Protective Feature**[1]	**Feature Type** <u>C</u>redited <u>D</u>efense	**Feature Purpose** <u>P</u>revent <u>M</u>itigate	**Reference to TSRs**
	Without Prevention[1]	**With Prevention**	**Without Mitigation**[1]	**With Mitigation**	**Without Prevention/ Mitigation**	**With Prevention/ Mitigation**				
CW	Case A Anticipated	Case A Anticipated	Case A Low	Case A Low 0 047 rem	Case A III	Case A III	Same as MOI			
	Case B Unlikely	Case B Unlikely	Case B High	Case B Moderate 6 2 rem	Case B I	Case B II				
	Case C Extremely Unlikely	Case C <u>Beyond</u> Extremely Unlikely	Case C High	Case C Moderate <u>2 7</u> rem	Case C II	Case C <u>not applicable</u>				
	Case D Extremely Unlikely	Case D <u>Beyond</u> Extremely Unlikely	Case D High	Case D High 390 rem	Case D II	Case D <u>not applicable</u>				

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Table 96 Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures

Hazard	4A (Radioactive Materials/Category I and II SNM), 4B (Radioactive Materials/Waste Container)
Accident Type	Puncture of wooden LLW crate (Case A), 2 TRU drums (Case B), single POC (Case C), or single Type B (Case D) Effective MAR = 0 3 grams aged WG Pu equivalent (10% damage ratio) (Case A), 40 grams aged WG Pu equivalent (10% damage ratio) (Case B), 1,255 grams WG Pu equivalent [883 grams Class W] (Case C), 6,000 grams aged WG Pu equivalent oxide (Case D), accident can occur in storage areas and receipt/shipment areas
Cause or Energy Source	[causes] 11A (Receipt and Shipment of Waste Containers at the Dock), 11B (Receipt and Shipment of SNM Containers at the Dock) and 11C (Movement of Waste Containers in the Facility), [energy sources] 7A (Vehicles, Material Handling Equipment)
Applicable Activity(ies)	[most likely] SNM and WASTE, [less likely] CHEM, GEN, CON, MAINT, RA, and SURV

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
IW	Case A Anticipated	Case A Anticipated	Case A Moderate	Case A Low	Case A I	Case A III	Metal Waste Container [F10]	C	P	AC 5 2
							Type B Shipping Container [F11]	C	P	AC 5 2
	Case B Unlikely	Case B Unlikely	Case B Moderate	Case B Low	Case B II	Case B III	POC Container [F12]	C	P	AC 5 2
							Container Rad Material Loading [G2, G4, G5, G6, G9]	C	M	AC 5 2
	Case C Extremely Unlikely	Case C Beyond Extremely Unlikely	Case C Moderate	Case C Low	Case C III	Case C not applicable	Emergency Plan [R12]	C	M	AC 5 6
							Radiation Protection [R21]	C	M	RAD
	Case D Extremely Unlikely	Case D Beyond Extremely Unlikely	Case D Moderate	Case D Low	Case D III	Case D not applicable	Training	D	P/M	TRAIN
							LS/DW	D	M	AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

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5.6 CONTAINER EXPLOSION SCENARIO ACCIDENT ANALYSES

5.6.1 Container Explosion Scenario Development and Selection

One bounding container explosion scenario was identified in Section 4 3 6 5, *Bounding Container Explosion Scenarios Determination* The scenario, B-CEXPLO-1, involves the *extremely unlikely* internal hydrogen explosion of a metal TRU waste container due to the accumulation of hydrogen within the container

The SARAH (Ref 8) specifically addresses container overpressurization due to internal hydrogen explosions Based on industry tests cited in the SARAH, drum lids will separate from the drum if drum free volume gases containing greater than 15% hydrogen and 7 5% oxygen, by volume, are ignited Aqueous sludge waste containers at the Site have been sampled and found to contain as much as 14 5% hydrogen and sufficient oxygen to completely burn the hydrogen

A typical waste container interior is expected to contain most of the gases in the container head space above the solid materials found in the container Polyethylene bags surrounding the solid materials may have deteriorated but would likely provide some protection from the explosion of the head space gases While some gases may occupy spaces within the solid material, the majority of gases involved in the explosion are assumed to be located in the head space area of the container Most of the force of any explosion that occurs will be in the direction of the separated lid and away from the solid material in the container Therefore, only a fraction of the solid material in the container would be subjected to the overpressure transient in a manner that would lead to a release As stated earlier in the Hydrogen Generation in Metal Waste Containers sub-section of Section 4 1 11, *Other Hazards (Hazard/Energy Source 13)*, a concurrent fire involving the waste container contents is judged not to occur following the overpressurization and lid loss due to the rapidity and low energy of the excursion (Ref 31)

There is no need for identification of variations of the bounding container explosion scenario due to the specificity of the accident Therefore, the container explosion scenario to be analyzed is

Container Explosion Scenario 1 - TRU Waste Box Container Explosion This container explosion involves the contents of one TRU waste box The box is assumed to have accumulated hydrogen from radioactive material content radiolysis processes and ignition mechanisms for the accumulated hydrogen are prevalent and uncontrollable The container hydrogen explosion results in the loss of the waste container lid and release of some of the radioactive material contents of the container The largest inventory TRU waste container is assumed in the analysis (*i e*, a TRU metal waste box or TRUPACT II SWB containing up to 320 grams, WG Pu equivalent) The container hydrogen explosion can occur throughout the Building 991 Complex where TRU waste containers are handled or stored The event can occur at the west dock and Room 170, and the east dock, in any of the waste storage areas, or in hallways used for waste container transit between the docks and the waste storage areas

5.6.2 Container Explosion Scenario 1 - TRU Waste Box Container Explosion

This accident scenario is discussed below and is summarized in Table 98 located at the end of Section 5 6, *Container Explosion Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

Hydrogen generation in metal waste containers (*Hazard/Energy Source 13A*, bounds hazard associated with pressurized containers, *Hazard/Energy Source 6C*) is postulated to lead to an internal hydrogen explosion in a TRU waste container (*Hazard/Energy Source 4B*) The radioactive decay of the TRU waste material interacts with hydrogenous waste materials and produces hydrogen and oxygen gases The gases are retained in the metal waste container and allowed to accumulate to the point where a hydrogen explosion potential exists Since as little energy as is associated with a static charge can ignite flammable hydrogen/oxygen mixtures, static charges generated by container movements ignite the hydrogen Therefore, the container explosion can occur at any point in the handling of the container (*i e*, at the storage location, at the dock, and during transit) Since the container loses its lid as part of the scenario, the material impacted by the event is no longer confined The scenario deals with an overpressure event that is conservatively assumed to impact radioactive material in the form of a powder The scenario is modeled as a 10 minute release A ground-level (non-lofted) release of the radioactive material is assumed

Scenario Modeling Assumptions internal overpressure, powder, 10 minute duration, non-lofted plume

Accident Frequency

The postulated accident scenario is considered to be an *extremely unlikely* event The likelihood of this scenario is primarily defined by a protective feature assumed in the analysis

- Feature F13 indicates that metal waste containers are *extremely unlikely* to be breached by internal hydrogen explosions due to metal ***waste container venting***

Waste container venting precludes the accumulation of hydrogen in the waste container as long as the vent remains open except for cases of extremely high hydrogen generation rates as might be associated with a chemical reaction occurring in the container rather than just radiolysis Since the distance through the filter is short relative to the diameter of the filter, the migration of hydrogen through the vent is not vent limited as might be the case for vented tanks with long vent lines The driving force for the hydrogen in the container is primarily the buoyancy of the hydrogen gas relative to air The equilibrium concentration of hydrogen gas in a vented TRU waste container is expected to be well below the 15% hydrogen concentration levels needed to cause a breach of the waste container

The likelihood of the event is dependent on (1) the amount of radioactive material in the container that impacts the rate of hydrogen generation, (2) the amount of hydrogenous material in the container that impacts the rate of hydrogen generated, (3) the extent to which the vent is plugged that impacts the ability of the container to retain the hydrogen, and (4) the length of time that the container vent is plugged relative to the container hydrogen generation rate The containers being analyzed are TRU waste containers that have the potential to generate hydrogen but not at rates as high as residue drums The containers may contain hydrogenous materials in the form of plastics and paper but waste containers with ***liquids are prohibited*** from the Building 991 Complex that reduces the rate of hydrogen generation compared to containers with high water content Vent plugging has been observed in containers with reactive chemical components (*e g*, acids) where the fumes from the chemicals can act on the vent leading to corrosion product buildup and vent plugging Since ***liquids are prohibited***, the extent of reactive chemicals in the Building 991 Complex TRU waste is limited, which reduces the likelihood of vent plugging due to chemical attack Containers will be retained in the complex for extended periods of time, which eliminates any hydrogen explosion likelihood reduction associated with retention time

Scenario Modeling Assumptions *extremely unlikely* event

<u>Material-At-Risk</u>

Only a single TRU waste container is involved in the container explosion event Multiple contiguous vented waste containers having explosive concentrations of hydrogen and oxygen accumulated in the containers is considered to be a *beyond extremely unlikely* event given that the occurrence of a single container with explosive concentrations of hydrogen and oxygen is considered to be an *extremely unlikely event* Based on General Assumption G4, no more than 320 grams (WG Pu equivalent) of radioactive material will be in a TRU waste box and this is imposed as a ***container radioactive material loading*** limitation The container involved in the explosion event is conservatively assumed to be Solubility Class W

As stated earlier, not all of the solid material in the waste container is impacted by the explosion since the predominance of gases are located at the top of the container in the head space and most of the force of the explosion would be in the direction of the container lid loss The SARAH (Ref 8) recommends that a small damage ratio be used for the internal waste container hydrogen explosion (*i e*, DR = 0 1) The DOE Handbook on release fractions (Ref 7) recommends an ARF value of 0 1 and a RF value of 0 7 for the venting of pressurized gases over contaminated, non-combustible material where the volume is pressurized The ARF and RF values in the DOE Handbook are based results of experiments dealing with confinement failures of pressurized containers containing solid material in the form of powder and these values will be conservatively applied to the TRU waste container hydrogen explosion scenario

Scenario Modeling Assumptions single container, aged WG Pu, 320 grams, Solubility Class W, DR = 0 1

<u>Accident Consequence</u>

The radiological dose consequences of container explosions involving TRU waste containers were originally assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class II for both receptors (*extremely unlikely* frequency, *high* consequence) Based on Table 2, the radiological dose consequences of unmitigated explosions were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class III for the IW (*extremely unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of a container explosion involving a single TRU waste box are *moderate* (2 6 rem) to the MOI and *high* (350 rem) to the CW The resulting risk class for the scenario is Risk Class III for the MOI (*extremely unlikely* frequency, *moderate* consequence) and is Risk Class II for the CW (*extremely unlikely* frequency, *high* consequence)

The IW located in the vicinity of the container explosion could have been seriously injured as a result of being impacted by the container lid There is the potential for the IW to inhale radioactive material being carried in the release plume from the explosion (2.24 grams) but the IW would have to remain in the vicinity of the container or in the path of the plume It would be relatively easy for the IW to vacate the area with minimum dose impact if the IW is not incapacitated The radiological dose consequences for the IW are qualitatively judged to be *moderate*, consistent with Table 2 for mitigated explosions, due to (1) the moderate amount of radiological material that is released, (2) the rapid rate of release (*i e*, puff release that places all the released material into the air in a very short time), (3) the indicators of the explosion (*e g*, loud noise, loss of container lid) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for the scenario is Risk Class III for the IW (*extremely unlikely* frequency, *moderate* consequence)

The IW located in the facility but away from the accident will not be exposed to the container explosion accident (no injury potential) but could be exposed to the radioactive material release plume There are no systems in the facility that will provide warning to the IW in the facility but away from the accident However, the mechanisms that are identified for initiation of this event deal with waste container handling that requires personnel participation These personnel, unless incapacitated, will be able to make an announcement over the ***LS/DW system*** leading to evacuation, per the facility ***emergency plan***, of any facility IW unaware of the event The consequences for the initially unaware IW are qualitatively judged to be *low* due to (1) the moderate amount of radiological material that is released, (2) the indicators of the explosion (*e g*, ***LS/DW***) that informs the IW of the event, (3) the limited potential for the radioactive material release plume to migrate throughout the facility, and (4) the building ***emergency plan*** that directs the IW to evacuate No risk class designation for the initially unaware IW is provided

Control Set Adequacy/Vulnerability

Two preventive features have been credited in the determination of the scenario frequency and two mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the Administrative Control for ***waste container vents*** on all sealed, metal waste containers (all receptors), and

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2 the Administrative Control that ***liquids are prohibited*** in waste containers to be stored in the Building 991 Complex (all receptors)

The credited mitigative features are

1 the Administrative Control of ***container radioactive material loading*** (all receptors), and

2 the Administrative Control of an ***emergency plan*** (IW only)

Failures of the preventive features are already assessed in the scenario frequency determination process and will not be addressed further

Failures of the ***container radioactive material loading*** mitigative feature (higher MAR containers, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR The dose consequence bin assignment is already ***high*** for the CW so MAR increases will increase dose consequences but <u>no change in the scenario CW risk class</u> will result It would take almost 2 times the MAR to be involved in an accident scenario to yield a change in the MOI dose consequence bin assignment (from 2 6 rem to 5 rem) This equates to a container inventory of approximately 640 grams Inventory errors of this magnitude are possible and would change the consequence bin assignment for the MOI to ***high*** with no change in scenario frequency Therefore, for the container explosion event, the <u>scenario risk class for the MOI increases</u> to Risk Class II from Risk Class III due to failure of the ***container radioactive material loading*** mitigative feature

Failures of the ***emergency plan*** mitigative feature (inadequate plan, one frequency bin reduction due to sensibility of evacuation and standardized guidance) could result in additional IW exposure to airborne radioactive materials Since the scenario was determined to be an *extremely unlikely* event, failure of the ***emergency plan*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Filtered Exhaust Ventilation*** (MOI and CW only) For container explosions in ventilated areas (north waste storage areas), the ***filtered exhaust ventilation*** systems of the facility can aid in scenario mitigation by filtering facility exhaust and reducing the radiological dose consequences of the CW and the MOI

- ***Training*** (IW only) The IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***LS/DW*** (IW only) Facility management or other personnel can utilize the ***LS/DW system*** to reduce IW consequences by providing indication of a container explosion to facility personnel

In summary, the analyzed accident scenario yields Risk Class II results for the CW and Risk Class III results for the MOI and the IW Failures of the individual mitigative feature of ***container radioactive material loading*** concurrent with the accident increases the risk class of the scenario for the MOI from Risk Class III to Risk Class II

5.6.3 Container Explosion Scenario Assumptions, Features, Requirements

In the evaluation of the container explosion scenarios, assumptions, protective features, and requirements were identified for prevention and/or mitigation of the accidents This information is found in Section 4 3 6 5, *Bounding Container Explosion Scenarios Determination*, and in Section 5 6, *Container Explosion Scenario Accident Analyses* Table 97 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of container explosion scenarios The scenarios to which each assumption, feature, or requirements applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 97 Assumptions/Features/Requirements for Container Explosion Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Container Explosion Scenario 1	Sets the potential MAR for the scenario impacting TRU waste containers ***Container Radioactive Material Loading***
F13	Metal waste containers are *extremely unlikely* to be breached by internal hydrogen explosions due to metal waste container venting	Container Explosion Scenario 1	Reduces the likelihood of metal waste container failure for scenarios dealing with internal hydrogen explosions by two frequency bins ***Waste Container Vents***
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	Container Explosion Scenario 1	Reduces the exposure to the IW to releases ***Emergency Plan***
R22	Waste containers to be stored in the Building 991 Complex shall not contain liquids	Container Explosion Scenario 1	Reduces the likelihood of internal hydrogen explosions in containers by reducing the potential rate of hydrogen generation ***Liquids in Waste Prohibited***

Table 98 Container Explosion Scenario 1 - TRU Waste Box Container Explosion

Hazard	4B (Radioactive Materials/Waste Container), 6C (Pressure Sources/Pressurized Metal Waste Containers), and 13A (Other Hazards/Hydrogen Generation in Metal Waste Containers)
Accident Type	Container Explosion involving a single TRU waste box, hydrogen and oxygen accumulate in sealed container and are ignited by spark, Effective MAR = 32 grams of aged WG Pu (10% damage ratio), accident can occur anywhere in the complex where waste containers are handled
Cause or Energy Source	[causes] 13A (Hydrogen Generation in Metal Waste Containers) [energy sources] container movement
Applicable Activity(ies)	WASTE and SURV

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
MOI	Extremely Unlikely	Extremely Unlikely	High	Moderate 2 6 rem	II	III	<u>Waste Container Vents</u> [F13] <u>Liquids in Waste Prohibited</u> [R22] Container Rad_Material Loading [G4] Filtered Exhaust Ventilation	C C C D	P P M M	AC 5 2 AC 5 2 AC 5 2 AC 5 5
CW	Extremely Unlikely	Extremely Unlikely	High	High 350 rem	II	II	Same as MOI			
IW	Extremely Unlikely	Extremely Unlikely	<u>Moderate</u>	Moderate	<u>III</u>	III	<u>Waste Container Vents</u> [F13] <u>Liquids in Waste Prohibited</u> [R22] Emergency Plan [R12] Container <u>Rad</u>_Material Loading [G4] Training LS/DW	C C C C D D	P P M M M M	AC 5 2 AC 5 2 AC 5 6 AC 5 2 TRAIN AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

5.7 FACILITY EXPLOSION SCENARIO ACCIDENT ANALYSES

5.7.1 Facility Explosion Scenario Development and Selection

One bounding facility explosion scenario was identified in Section 4 3 6 6, *Bounding Facility Explosion Scenarios Determination* The scenario, B-FEXPLO-1, involves the *extremely unlikely* impact of a facility explosion on a waste storage area inventory (either LLW and/or TRU waste containers types).

The hazards initially identified in the hazard identification and evaluation process dealt with propane (*Hazard/Energy Source 5B*) and natural gas (*Hazard/Energy Source 5C*) Calculation CALC-RFP-98 0555-RGC (Ref 39) analyzed the potential that a dispersion of a large source of propane vapor from the 750 Pad tank farm could migrate to the Building 991 Complex The 750 Pad tank farm consists of eight 1,000-gallon propane tanks connected together by a common manifold to serve the ten heater/vaporizer units for the storage tents on the 750 Pad The 750 Pad tank farm is located west of, and on the hillside above, the Building 991 Complex The distance between the tank farm and the complex is greater than 400 feet The area between the tank farm and the complex is a grass covered ravine with a small stream An elevated road (with at least a 10 foot rise) runs across the ravine between the tank farm and the complex At the point where the ravine meets the elevated road, the stream is diverted into a culvert that runs on the south side of the Building 991 Complex

In the calculation, the bounding scenario considered for a large source of propane vapor was the catastrophic failure and subsequent spill from one 1,000-gallon propane tank. The failure occurs due to a high energy impact from a propane tanker truck or other type of vehicle Failures of the manifold piping connecting the eight tanks would lead to a lower release rate with less downwind propane concentration but would increase the duration of the vapor cloud The calculation utilized a dense gas dispersion model that does not account for surface roughness and momentum induced turbulence to compute the propane concentration at a downwind distance from the 750 Pad tank farm Surface roughness and momentum induced turbulence within the vapor cloud would lead to increased diffusion and propane concentrations consistently lower than the model prediction

The calculation concluded that the postulated propane release will not remain flammable beyond 70 feet from the release point For conservatism and to account for model uncertainties, the calculation recommended that a separation distance of 150 feet be maintained to ensure that the flammable mixture is not entrained into a confined space (*e g*, ventilation ducts, culvert)

Based upon the conclusions of the calculation, the likelihood of high concentrations (*i e*, above flammability limits) of propane migrating from the 750 pad tank farm to the Building 991 Complex is considered to be a *beyond extremely unlikely* event This likelihood determination is based on (1) the distance that the propane vapor cloud would have to travel (*i e*, greater than 400 feet versus the recommended 150 foot separation), (2) the stated conservatism of the calculation dealing with omission of surface roughness and vapor cloud momentum induced dispersion, and (3) the location of the elevated road between the tank farm and the complex that would require that the propane vapor cloud rise up over the road in order to reach the complex leading to additional propane dispersion and concentration reduction Therefore, no further analysis of this hazard is necessary

Calculation CALC-RFP-98 0555-RGC (Ref 39) also analyzed the potential effects of a natural gas jet explosion A gas jet scenario was the only condition found on Site in which a natural gas release could lead to a significant blast wave overpressure In the gas jet explosion scenario, it was assumed that a natural gas line attached to the outer surface of a building breaks A jet plume results from the line break and an ignition source was assumed to ignite the flammable portion of the plume, resulting in a violent explosion In the assumed scenario, the explosion burns the gas in the plume If the ignition source remains within the area of the plume, the natural gas plume could be re-ignited, thereby repeating the event until such time that the flow of natural gas through the line break was stopped The calculation provided an expected overpressure and impulse duration for the natural gas jet explosion but did not analyze the specific effects of such explosions on Site facility walls The calculation indicated that the resulting peak pressure felt at the wall was 22 8 psi Since the duration of the explosion is very short (2 6 msec), the damage to the wall would be impulse dependent The duration of the calculated impulse is significantly below the typical resonance frequency of walls, which is on the order of 10 Hz or a 0 1 second period Therefore, the calculation concluded that the potential damage from the natural gas jet explosion to concrete or masonry walls would be negligible but that damage to other construction types required additional evaluation

For the Building 991 Complex, natural gas is provided to fuel the weatherproof boilers located approximately 15 feet east of Room 166 of Building 991 The natural gas line follows the steam line to the complex before it is routed to the boilers The natural gas line comes within approximately 1 foot of the top of the northeast corner of Room 166 before it goes east to the boilers Room 166 of Building 991 is going to be used as a radioactive waste storage area. The room is constructed of concrete block walls with a single glass pane window located on the north wall of the room that could be subjected to natural gas jet explosions The walls of the room would be expected to survive the overpressure effects of the natural gas jet explosion, due to their construction, but it is not expected that the window would survive the explosion If the window is breached by the initial explosion and the natural gal line leak and ignition sources are still present after the explosion, it is possible that natural gas from the leak could migrate into Room 166 through the broken window and accumulate inside the room up to concentrations above flammable levels Under these conditions, radioactive waste containers stored in the room could be exposed to a follow-on natural gas explosion

Due to the possibility of this scenario occurring, the Room 166 glass pane ***window must be covered or eliminated*** in such a manner that the likelihood of natural gas getting into Room 166 with a subsequent gas explosion that can impact waste containers in the room is reduced to a *beyond extremely unlikely* event The window, for example, could be covered with a metal plate located on the outside of the wall (reduces likelihood of plate being driven into the room by an external natural gas explosion) with sealant around the plate to prevent natural gas migration into the room, or the window could be blocked in with concrete blocks Whatever means are chosen to cover or eliminate the window in Room 166 will reduce the likelihood of natural gas explosions impacting waste containers to *beyond extremely unlikely* events and no further analysis of these events are necessary An alternative control is to ***restrict Room 166 storage to POC containers*** POC containers were excluded from further evaluation based on crediting Feature F9, which state that POC containers cannot be breached by any external flammable gas explosions expected during facility operation Therefore, the likelihood of a natural gas explosion in Room 166 impacting POC containers is considered to be a *beyond extremely unlikely* event

The propane hazard (*Hazard/Energy Source 5B*) was intended to represent any of a number of flammable gases that may be used in the Building 991 Complex Acetylene is another flammable gas that may be used in the complex and poses similar, if not greater, risks to the facility than the use of propane due to the explosive yield of acetylene being greater than that for equivalent quantities of propane Most of the following discussions address the use of acetylene to cover the perceived greater risk associated with that product

Acetylene gas welding, cutting, and brazing may be conducted at various locations throughout the Building 991 Complex, including waste storage areas, during construction and maintenance activities Acetylene cylinder volumes may range from 10 ft^3 to 300 ft^3

For flammable gases used in Building 991 Complex (specifically acetylene), transition from a deflagration explosion to a detonation explosion depends on the flammable gas mixture, temperature, and pressure, on the size of the enclosed room, and on the ignition source With a powerful ignition source, detonation may occur upon ignition, even in the open However, explosions of gases (both lighter- and heavier-than-air) and liquid vapors are nearly always deflagrations and are seldom detonations (Ref 40) Detonation explosions of fuel/air mixtures can potentially occur under the following restrictive conditions (1) the fuel/air cloud must nearly fill, or be confined by, the closed volume it occupies, (2) the fuel/air mixture must have a concentration within the detonable range, and (3) a highly energetic ignition source must initiate the explosion (Ref 41) The ignition energy required to initiate a detonation is usually many orders of magnitude greater than that required to initiate a deflagration (Ref 42) For acetylene, the minimum ignition energy to ignite a detonation is 5 3 kJ (propane ignition energy is 210 kJ) An electric arc in a shorted 50-75 horsepower motor would appear to be sufficient to ignite an acetylene detonation For the Building 991 Complex, it must be assumed that such an ignition source may be present, however, the remaining two conditions must still be met in order to have a detonation For the situations of concern within the Building 991 Complex, the most likely mode of combustion of a fuel/air mixture is a deflagration

The drum failure criterion for a deflagration, defined as the apparent, external crushing pressure at lid failure, is conservatively calculated as 22 psig (Ref 41) based on static drum compression tests performed at the Sandia National Laboratories However, structural degradation (of interior/exterior walls, ceiling slab, overhead items, *etc*) as a result of increasing pressure would be a concern prior to 22 psig Impacts from falling debris can breach waste containers within the waste storage areas

As stated earlier, acetylene cylinders come in various sizes up to 300 ft^3 Since flammable gas explosion potential is related to the concentration of the gas in an enclosed volume, waste storage areas within the Building 991 Complex can be examined to determine those rooms for which a release of an acetylene cylinder contents could lead to flammable concentrations of the gas when mixed with air in the room This type of situation can potentially lead to flammable gas explosions and significant room overpressure Building 991 Complex waste storage areas are identified in Table 99 along with approximate room volumes and the amount of acetylene gas, that if released and uniformly mixed with the total volume of room air, would result in a flammable air/acetylene mixture

Table 99 Building 991 Complex Waste Container Storage Areas

ROOM/ BLDG.	SQUARE FOOTAGE (ft^2)	CEILING HEIGHT (ft)	APPROXIMATE VOLUME (ft^3)	VOLUME OF ACETYLENE TO REACH LFL OF 2.5% (ft^3)
134	1,925	27	51,975	1,299
135	200	10	2,000	50
140/141/153	3,600	20	72,000	1,800
142	448	10	4,480	112
143	500	20	10,000	250
148	200	10	2,000	50
151	936	20	18,720	468
155	648	20	12,960	324
158	300	10	3,000	75
166	1,184	20	23,680	592
170	3,000	25	75,000	1,875
996	856	10	8,560	214
998	1,725	10	17,250	431

Combustion of acetylene, whether it is a deflagration or detonation, can occur only when the concentration is within the flammable range, which is between 2 5% and 81% by volume From Table 99, Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 could potentially contain a flammable air/acetylene mixture if welding, cutting, or brazing were performed and up to 300 ft^3 of acetylene is inadvertently released and mixed uniformly with the entire volume of room air Assuming that these smaller rooms act as enclosed volumes, the acetylene gas deflagration could be confined and result in higher maximum overpressure values, potentially resulting in container failure, than an unconfined deflagration in a larger volume room Therefore, the ***use of acetylene in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited*** and flammable gas explosions in these waste storage areas does not require further evaluation

In larger volume rooms or areas, including Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, and Building 998, the combustion process will be limited to a localized air/acetylene mixture within the flammable range It is reasonable to model explosions in these larger rooms as unconfined deflagrations based on the largest volume of a flammable air/acetylene mixture being approximately 12,000 ft^3 (based on the lower flammability limit and 300 ft^3 of acetylene) compared to room volumes of from 12,960 ft^3 to 75,000 ft^3 When a volume of gas or vapor in air deflagrates in an unconfined space, only a small fraction of the energy in the cloud actually contributes to any result damage (Ref 43) This fraction is referred to as the yield factor

The facility explosion scenario to be analyzed is

Facility Explosion Scenario 1 - Explosion in Waste Container Storage Area This facility explosion is assumed to occur following a release of acetylene gas into a waste container storage room with a deflagration limited to a localized air/acetylene mixture within the flammable range This postulated explosion impacts the entire radiological waste container inventory (*Hazard/Energy Source 4B*) of the specific waste storage area (room) where the explosion occurs Room inventories consist of radioactive materials packaged in Type B shipping containers, POC containers, metal TRU waste containers, metal LLW waste containers, and wooden LLW waste containers Type B shipping containers and POC containers were excluded from further evaluation based on crediting Feature F8 and Feature F9, which state that Type B shipping containers and POC containers cannot be breached by any external flammable gas explosions expected during facility operation Therefore, the likelihood of a facility explosion impacting Type B shipping or POC containers is considered to be a *beyond extremely unlikely* event.

5.7.2 Facility Explosion Scenario 1 - Explosion in Waste Container Storage Area

This accident scenario is discussed below and is summarized in Table 101 located at the end of Section 5 7, *Facility Explosion Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

<u>Accident Scenario</u>

It is postulated that a full 150 ft^3 acetylene cylinder ruptures and the entire contents is released into a waste storage area (room) A release from a 150 ft^3 acetylene cylinder is postulated based on previous analyses performed for the Building 371/374 Complex, which are discussed in subsequent paragraphs A release of acetylene gas can occur as a result of failure of (*e g*, manufacturing deficiency) or damage to (*e g*, toppling/dropping of cylinder, kinetic energy, puncture) the gas cylinder or ancillary equipment (*i e*, cylinder valve, regulator, relief device, hoses, torch, *etc*) during construction or maintenance activities Following the release, the acetylene will mix with surrounding room air

For this analysis, it is assumed that 150 ft^3 of acetylene is rapidly released into a larger volume room (*i e*, Room 134, Room 140/141/153, Room 151, Room 156, Room 166, Room 170, or Building 998) and mixes with room air to form a localized, flammable mixture for a limited period of time due to continued mixing While the flammable mixture is present, it is postulated that an ignition source (*e g*, electric power system, *Hazard/Energy Source 5E*) ignites the acetylene to produce a deflagration within the room The MAR for this analysis is the entire radiological inventory in the waste container storage room where the explosion occurs, packaged as either LLW or TRU waste

A conservative engineering analysis (Ref 41) calculated that a deflagration of 150 ft^3 of acetylene in a hermetically sealed enclosure with a volume of 18,085 ft^3 will yield an overpressure of approximately 22 psig, which is equivalent to the external static compression pressure determined to be necessary to cause failure of the drums However, because the acetylene is dissolved in an acetone carrier, the release process will be relatively slow The deflagration of the entire container content is unlikely to occur without sufficient dispersion (due to the duration of the release) to prevent flammability of a large fraction of the total Therefore, a conical jet from a 1-inch orifice is modeled consistent with Site methodology

The length of the conical jet is estimated to be 16 7 feet based on the fact that "100-fold dilution will be achieved by jet action alone within a distance of 200 nozzle diameters" The quantity of acetylene released is approximately 10% of the total content, or 15 ft^3 from a 150 ft^3 cylinder The release is determined to be contained within a conical jet with a volume of 141 ft^3 The mixture concentration is therefore 10 6%, which is well within the flammable range. The resultant overpressure from the deflagration explosion would be approximately 0 31 psig for a room volume of 105,000 ft^3, 0 78 psig for a room volume of 49,500 ft^3, and 3 3 psig for a room volume of 12,540 ft^3 The overpressure will occur virtually uniformly throughout the room as the explosion evolves This overpressure is much less than 22 psig and is not sufficient to produce lid failure of 55-gallon drums The analysis in the Building 371/374 Complex BIO concludes that a 15 ft^3 release of acetylene into a room with a volume greater than approximately 12,000 ft^3 would result in an overpressure that does not exceed 3 5 psig (which is the peak overpressure judged to be a reasonable internal criterion to ensure that damage within the Building 371/344 Complex would be localized) However, it is conservatively assumed that 10 drums are breached because of impacts with debris resulting from explosion overpressure effects Based on the evaluation of the Building 371/374 facility acetylene explosions, welding, cutting and brazing using acetylene gas will be authorized in Building 991 Complex waste storage areas with volumes greater than 12,000 ft^3 The scenario is modeled as a 10 minute release A ground-level (non-lofted) release of the radioactive material is assumed

Scenario Modeling Assumptions spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The postulated accident scenario is considered to be an *extremely unlikely* event The scenario requires (1) the failure of the acetylene cylinder or associated plumbing, (2) acetylene mixing with room air to form a flammable mixture, and (3) introduction of an ignition source The flammable mixture will only exist for a limited time due to continued mixing, which could be enhanced by active ventilation (an expected condition even though not credited, since one condition for welding is that general ventilation be established per HSP 12 11, *Welding, Cutting,* *and Brazing*) The likelihood of this scenario is primarily defined by the following conditions or assumptions made in the analysis

- Feature F17 indicates that the breach of any ***flammable gas container*** that are used in the performance of activities must be an ***unlikely*** event due to container resistance to impacts, and

- Requirement R9 requires that a ***hot work control*** program be implemented for the Building 991 Complex to make flammable gas explosions in areas containing staged, stored, or in-process (*i e* , GEN activity) radioactive material ***unlikely*** events

Inherent in the likelihood determination for facility explosions that impact stored waste containers is the resistance of the ***metal waste drum*** to overpressure events requiring at least 22 psig overpressure to result in container failure

Scenario Modeling Assumptions ***extremely unlikely*** event

Material-At-Risk

An unconfined deflagration of 150 ft^3 of acetylene in Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, or Building 998 is assumed to result in a peak overpressure less than the 22 psig required to breach a ***metal waste drum*** The overpressure is not sufficient to rupture 55-gallon drums and it is also insufficient to topple stacked drums since the overpressure is essentially uniform throughout the room (*i e*, the pressure will be exerted on the drums from all sides) It is conservatively assumed, however, that 10 TRU waste drums are breached TRU waste drums are evaluated and bound the consequences associated with LLW containers The 10 drum assumption ensures that any debris impacts are enveloped by the analysis as is the unanalyzed scenario of a missile generated by the failure of a compressed gas cylinder The actual number of drums breached (*i e* , penetrations through the metal container, the drum liner, and internal packaging) is expected to be much less than the 10 drums that are analyzed Very few ceiling fixtures in waste container storage areas have sufficient mass to penetrate drums when dropped from the ceilings The approach taken in the evaluation of a seismic event (see Section 5 9 2, *NPH/EE Scenario 1 – DBE Event-Induced Spill*) will be used to assess the conservatism of the 10 drum breach The analysis of the BDBE event analyzed in Section 5 9 3, *NPH/EE Scenario 2 – BDBE Event-Induced Spill*, assumes more ceiling damage than that expected to result from the acetylene explosion but will also be used for comparison purposes

It is assumed that 10% (50% for a BDBE event) of the exposed drums (drum lids exposed to the ceiling) in a room will be subject to ceiling debris induced by the acetylene explosion The 10% value is based on engineering judgment and is believed to be conservative since the ceiling is not totally collapsing and there is a limited amount of overhead materials available in the facility to fall onto drums There are overhead cranes in Room 134 and Room 170 that could potentially impact waste containers but these cranes are not expected to fall as a result of the explosion The HVAC ductwork in the facility only covers a small portion of the total ceiling area and may not have sufficient mass to breach waste containers Heating units in various portions of the facility may have sufficient mass to result in container breach but cover even a smaller portion of the total ceiling area and probably will not fall as result of the explosion

Of the drums subjected to falling debris, it is assumed that 10% (for both the DBE and BDBE events) of the drums are breached to the point of losing confinement of radioactive material contents The 10% value is also based on engineering judgment and takes into account the strength of the drums (*i e*, ***metal waste drum/container*** controls) and the types of overhead materials that may fall (*i e*, limited amount of heavy, penetrating overhead materials)

The number of exposed TRU waste drums varies in the rooms of the facility from a maximum of approximately 300 drums in Building 998 to 120 drums in Room 155 Note that the larger the room, the less overpressure and corresponding ceiling debris expected The range of breached drums varies from 3 to 1 under the DBE event assumption of 10% of the exposed drums being impacted by debris and from 15 to 6 under the BDBE event assumption of 50% of the exposed drums being impacted by debris The effect of the explosion on debris production is not well defined but is expected to be significantly less than that associated with a BDBE event where the ceiling is partially collapsing and equipment is shaken for a relatively long period of time as compared to an explosion event Therefore, the number of containers damaged is expected to be closer to the 3 than 15

Note that room inventories with less than 200 exposed drums and with volumes greater than 12,000 ft^3 would yield less than the assumed 10 drums, even under the BDBE event assumptions These rooms include Room 151 (134 exposed, about 7 breached), Room 155 (120 exposed, 6 breached), Room 166 (not of interest due to the ***restrict Room 166 storage to POC containers*** control), and Room 170 (192 exposed, about 10 breached) Building 998, Room 140/141/153, and Room 134 all have more than 200 exposed drums but are very large rooms with less impact expected from the explosion overpressure Room 170 is also a very large room and would be expected to have less explosive overpressure than Rooms 151 and 155 Therefore, an assumption of 10 drums being damaged by debris resulting from the flammable gas explosion is conservative and covers any additional drum damage from cylinder missile debris as a result of potential cylinder involvement in the explosion

It is judged appropriate, based on the energy of the event and the types of materials stored within the drums, to assume that the material is released as a spill The effective MAR is 2,000 grams (WG Pu equivalent, 10 TRU waste drums × 200 grams/drum) The ***container radioactive material loading*** limit of 200 grams (WG Pu equivalent) per TRU waste drum is specified as General Assumption G4 Additionally, a 150 ft^3 ***flammable gas inventory*** limit is imposed for Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, and Building 998 A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y The minimum number of drums involved in the explosion is 120 drums in Room 155, therefore, the use of a blended DCF is appropriate

Scenario Modeling Assumptions 10 drums, 2,000 grams, blended DCF, DR = 1

Accident Consequence

The radiological dose consequences of facility explosions involving LLW containers were assessed to be *moderate* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class III for both receptors (*extremely unlikely* frequency, *moderate* consequence) The radiological dose consequences of facility explosions involving TRU waste containers were assessed to be *high* for both the MOI and the CW This yielded an initial risk class for the scenario of Risk Class II for both receptors (*extremely unlikely* frequency, *high* consequence) Based on Table 2, the radiological dose consequences of unmitigated explosions were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class III for the IW (*extremely unlikely* frequency, *moderate* consequence)

The analyzed radiological dose consequences of the facility explosion induced spill involving ten 55-gallon TRU waste drums are *moderate* (0 17 rem) to the MOI and *moderate* (24 rem) to the CW The resulting risk classes for the scenario are Risk Class III for both the MOI and the CW (*extremely unlikely* frequency, *moderate* consequences)

For the IW located in the vicinity at the time of the event, a facility explosion could cause death or serious injury to those in the area at the time of the explosion due to the blast effects and due to the heat and flame associated with the deflagration There is the potential for the IW to inhale radioactive material being lofted by the spilled containers following the explosion (0 2 grams) but the IW would have to remain in the vicinity of the spill The radiological dose consequences to the IW that is in the vicinity of the explosion are qualitatively judged to be *moderate*, consistent with Table 2 for mitigated explosions, due to· (1) the potential for the IW to be incapacitated by the explosion and unable to exit the area (*i e*, the IW receives higher radiological consequences since they are unable to evacuate), (2) the moderate amount of radiological material that is released, (3) the indicators of the explosion (*e g*, loud noise, falling debris, smoke) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the IW to evacuate The resulting risk class for this scenario is Risk Class III to the IW (*extremely unlikely* frequency, *moderate* consequence)

The IW located in the facility but away from the accident will not be exposed to the explosion event (no injury potential) but could be exposed to a radiological release from the breached waste containers There are no systems in the facility that will provide warning to the IW in the facility but away from the accident unless the explosion sets off the ***automatic sprinkler system*** that would yield a ***water gong alarm*** to inform some complex personnel Personnel who become aware of the activation of the sprinkler system may make an announcement over the ***LS/DW system*** or may lift a ***fire phone*** and activate the facility ***fire alarm*** to inform other personnel in the complex who may not have heard the ***water gong alarm*** Personnel who are in the vicinity of the explosion and are not incapacitated will be able to make an announcement over the ***LS/DW system*** leading to evacuation, per the facility ***emergency plan***, of any facility IW unaware of the event The consequences for the initially unaware IW are qualitatively judged to be low due to (1) the moderate amount of radiological material that is released, (2) the potential explosion/fire detection/announcement devices (*e g*, ***water gong alarms***, ***fire phones***) that will provide signals to alarm functions, (3) the indicators of the explosion (*e g*, noise, ***fire alarms***, ***LS/DW***) that informs the IW of the event, and (4) the building ***emergency plan*** that directs the IW to evacuate No risk class designation for the initially unaware IW is provided

The consequences of this accident scenario concurrent with an ensuing fire is covered in the evaluation of facility fire scenarios in Section 5 3, *Facility Fire Scenario Accident Analyses* The postulated facility explosion scenario could be a precursor to the facility fire scenarios

Control Set Adequacy/Vulnerability

Three preventive features have been credited in the determination of the scenario frequency and four mitigative features have been credited in the scenario consequence determination The credited preventive features are

1 the hardware control that the Room 166 glass pane ***window must be covered or eliminated*** (all receptors) or the Administrative Control that ***restricts Room 166 storage to POC containers*** (all receptors),
2 the Administrative Control that assures ***flammable gas containers*** are *unlikely* to be breached during use (all receptors), and
3 the Administrative Control that requires a ***hot work control*** program be implemented for the Building 991 Complex to make flammable gas explosions in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events (all receptors)

The credited mitigative features are

1 the Administrative Control that the ***use of acetylene in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited*** (all receptors),
2 the Administrative Control for ***metal waste drum*** specifications (*i e*, cannot be breached by an explosion peak overpressure less than 22 psig) (all receptors),
3 the Administrative Control of ***container radioactive material loading*** (all receptors), and
4 the Administrative Control of ***flammable gas inventory*** limits (all receptors)

The Room 166 glass pane ***window must be covered or eliminated*** preventive feature is an alternate control for prevention of natural gas explosions from impacting Room 166 radioactive materials However, due to the difficulty in assuring/confirming that the window covering does provide the desired protection, only the ***restrict Room 166 storage to POC containers*** control is credited The failure of the ***restrict Room 166 storage to POC containers*** preventive feature (storage of TRU waste containers in Room 166, one frequency bin reduction due to simplicity of control) could result in natural gas explosion impacts in Room 166 Since the natural gas explosion scenario was considered to be an *extremely unlikely* event, failure of the ***restrict Room 166 storage to POC containers*** preventive feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

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Failures of the ***flammable gas containers*** preventive feature (inadequate design, failure to meet DOT specifications, one frequency bin reduction) could result in some cylinder breach events becoming *anticipated* events The accident scenario likelihood corresponding to these situations is as follows (note assumptions, features, or requirements that are shown with a line through the code indicate the failed protective feature)

- *extremely unlikely* scenario mechanism R9[U] & F17[U] becomes R9[U] & ~~F17~~[A] & feature failure[U] yielding an *extremely unlikely* event

Therefore, there is <u>no change in scenario risk class</u> due to a failure of the ***flammable gas containers*** preventive feature

Failures of the ***hot work control*** program requirement (control of ignition sources, fire watches, *etc*) could result in some events (related to R9) becoming *anticipated* events The accident scenario likelihood corresponding to these situations is as follows (note assumptions, features, or requirements that are shown with a line through the code indicate the failed protective feature)

- *extremely unlikely* scenario mechanism F17[U] & R9[U] becomes F17[U] & ~~R9~~[A] & feature failure [U] yielding an *extremely unlikely* event

Therefore, there is <u>no change in scenario risk class</u> due to a failure of the ***hot work control*** preventive feature

Failures of the ***use of acetylene in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited*** mitigative feature (use of acetylene in prohibited rooms, one frequency bin reduction due to simplicity of control) could result in increased overpressure effects resulting in increased MAR being involved in the accident scenario Since the scenario was determined to be an *extremely unlikely* event, failure of the ***use of acetylene in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***metal waste drums*** mitigative feature (potential breach of containers from explosion rather than just from debris, one frequency bin reduction due to standardization of waste containers) could result in additional MAR for the postulated scenario Since the scenario was determined to be an *extremely unlikely* event, failure of the ***metal waste drums*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***container radioactive material loading*** mitigative feature (underestimation of existing container inventory, one order of magnitude reduction in frequency, no change in scenario frequency bin) would result in additional MAR It would take only a 4% increase in the amount of MAR to be involved in an accident scenario to yield a change in the CW dose consequence bin assignment (from 24 rem to 25 rem) and even more MAR to change the MOI dose consequence bin assignment (factor of about 29 to go from 0 17 rem to 5 rem)

This equates to an average TRU drum inventory of over 208 grams in each of the 10 drums or a single drum inventory of 280 grams Inventory errors of this magnitude in individual drums are possible although errors of this magnitude in a large number of drums are considered to be *beyond extremely unlikely* events With inventory errors of this magnitude, the CW scenario consequences would increase to *high* for this event resulting in a Risk Class II scenario for the CW This increase in risk class is offset by (1) the fact that a large majority of TRU waste drums will not be packaged with 200 gram, the 95th UCL is 75 grams per drum, and (2) the conservative estimate that 10 drums would be breached by debris impact as a result of deflagration overpressure effects Also, the likelihood of a single drum containing 280 grams or a combination of 10 drums adding up to 2,080 grams being the set of drums breached by debris is considered to be at least an *unlikely* event This multiple drum ***container radioactive material loading*** error or large single drum ***container radioactive material loading*** error being associated with the impacted drum(s) concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

Failures of the ***flammable gas inventory*** mitigative feature (potential introduction of more flammable gas, one frequency bin reduction due to standardization of flammable gas containers) could result in increased overpressure effects resulting in increased MAR being involved in the accident scenario Since the scenario was determined to be an *extremely unlikely* event, failure of the ***flammable gas inventory*** mitigative feature concurrent with the scenario would be a *beyond extremely unlikely* event and does not require further evaluation

In all situations discussed above, the following defense-in-depth features tend to mitigate or prevent the scenario but are not credited in the analysis

- ***Training*** (all receptors) The operator ***Training*** program is an additional preventive feature that can potentially reduce the likelihood of damage to flammable gas cylinders and associated equipment or the buildup of flammable gases

- ***Emergency Plan*** (IW only) The ***Emergency Plan*** is an additional mitigative feature that can reduce IW consequences by providing evacuation guidance in the event of an explosion

- ***Training*** (IW only) The IW ***Training*** program is an additional mitigative feature that can reduce IW consequences as a reinforcement of the ***emergency plan*** evacuation guidance

- ***Water Gong Alarm/Automatic Sprinklers*** (IW only) ***Water gong alarm*** activation following ***automatic sprinkler system*** actuation may reduce IW consequences by providing indication of an explosion/fire to some facility personnel Sprinkler response may or may not occur as a result of the explosion

- ***Fire Phones/Local Fire Alarm*** (IW only) ***Fire phone*** use activates ***local fire alarms*** and can reduce IW consequences by providing indication of an explosion/fire to facility personnel Personnel may be aware of the explosion and use the ***fire phone***

- *LS/DW System* (IW only) *LS/DW system* use can reduce IW consequences by providing indication of an explosion/fire to facility personnel Facility management may be informed by various alarms or personnel may be aware of the explosion and use the *LS/DW system*

In summary, the analyzed accident scenario yields Risk Class III results for the MOI, CW, and IW Failures of individual preventive or mitigative features concurrent with the accident do not increase the risk class of the scenario for any receptor

5.7.3 Facility Explosion Scenario Assumptions, Features, Requirements

In the evaluation of the facility explosion scenarios, assumptions, protective features, and requirements were identified for prevention and/or mitigation of the accidents This information is found in Section 4 3 6.6, *Bounding Facility Explosion Scenarios Determination*, and in Section 5 7, *Facility Explosion Scenario Accident Analyses* Table 100 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of container explosion scenarios The scenarios to which each assumption, feature, or requirements applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 100 Assumptions/Features/Requirements for Facility Explosion Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Facility Explosion Scenario 1	Sets the potential MAR for the explosion scenarios impacting waste containers (200 grams for facility fires and container explosions) ***Container Radioactive Material Loading***
F9	POC containers cannot be breached by any external flammable gas explosions expected during operation	B-FEXPLO-1	Reduces the likelihood of POC container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely* ***POC Container***
F17	Flammable gas containers are *unlikely* to be breached during use	Facility Explosion Scenario 1	Reduces the likelihood of explosion or fire scenarios due to use of flammable gases by one frequency bin ***Flammable Gas Container***

Table 100 Assumptions/Features/Requirements for Facility Explosion Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F29	Metal waste drums cannot be breached by an external explosion peak overpressure less than 22 psig	Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Metal Waste Drum***
R9	A hot work control program shall be implemented to make flammable gas explosions in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	Facility Explosion Scenario 1	Reduces the likelihood of facility explosions potentially impacting radioactive material by one frequency bin ***Hot Work Control***
R23	The use of flammable gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited	B-FEXPLO-1 Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Use of Flammable Gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is Prohibited***
R24	The flammable gas inventory in Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, and Building 998 shall be limited to 150 ft^3	Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Flammable Gas Inventory***
R25	The glass pane window in Room 166 shall be covered or eliminated	B-FEXPLO-1	Reduces the likelihood of gas getting into Room 166 with a subsequent gas explosion that can impact waste containers stored in the room to a *beyond extremely unlikely* event Superceded by Room 166 Waste Storage Restrictions [R26]

Table 100 Assumptions/Features/Requirements for Facility Explosion Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R26	Room 166 can only be used to store POC containers, metal waste containers other than POC containers are prohibited from storage in Room 166	B-FEXPLO-1	In combination with ***POC container***, reduces the likelihood of a natural gas explosion in Room 166 impacting radioactive material to a *Beyond Extremely Unlikely* event ***Restrict Room 166 Storage to POC Containers***

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Table 101 Facility Explosion Scenario 1 - Explosion in Waste Container Storage Area

Hazard	4B (Radioactive Materials/Waste Container), 5B (Thermal Energy/Propane [Acetylene]), and 5E (Thermal Energy/Electric Power System)
Accident Type	Facility Explosion involving 10 TRU waste drums, flammable gas explosion in room creating falling debris with subsequent drum breaches Effective MAR = 2,000 grams of aged WG Pu, accident occurs in waste storage areas larger than 12,000 ft³
Cause or Energy Source	[causes] 5B (Propane [Acetylene]), [energy sources] 5E (Electric Power System) and hot work
Applicable Activity(ies)	[most likely] MAINT and WASTE, [less likely] CON and GEN

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
MOI	Extremely Unlikely	Extremely Unlikely	High	Moderate 0 17 rem	II	III	<u>Flammable Gas Container</u> [F17] <u>Hot Work Control</u> [R9] <u>Metal Waste Drum</u> [F29] Flammable Gas Prohibitions [R23] Flammable Gas Inventory [R24] Container <u>Rad</u> Material Loading [G4] Training	C C C C C C D	P P M M M M P	AC 5 3 AC 5 3 AC 5 2 AC 5 3 AC 5 3 AC 5 2 TRAIN
CW	Extremely Unlikely	Extremely Unlikely	High	Moderate 24 rem	II	III	Same as MOI			
IW	Extremely Unlikely	Extremely Unlikely	<u>Moderate</u>	<u>Moderate</u>	<u>III</u>	<u>III</u>	<u>Flammable Gas Container</u> [F17] <u>Hot Work Control</u> [R9] <u>Metal Waste Drum</u> [F29] Flammable Gas Prohibitions [R23] Flammable Gas Inventory [R24] Container <u>Rad</u> Material Loading [G4] Training Emergency Plan Water Gong Alarm/Automatic Sprinklers Fire Phones/Local Fire Alarm LS/DW	C C C C C C D D D D D	P P M M M M P/M M M M M	AC 5 3 AC 5 3 AC 5 2 AC 5 3 AC 5 3 AC 5 2 TRAIN AC 5 6 AC 5 5 AC 5 5 AC 5 5

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

5.8 CRITICALITY SCENARIO ACCIDENT ANALYSES

5.8.1 Criticality Scenario Development and Selection

Two bounding criticality scenarios were identified in Section 4 3 6 7, *Bounding Criticality Scenarios Determination* The first, B-CRIT-1, involves the ***unlikely*** rearrangement of an entire room or area of TRU waste containers resulting from facility structural failures leading to a criticality and involving the *extremely unlikely* rearrangement of an entire room or area of POC containers resulting from facility structural failures leading to a criticality The second, B-CRIT-2, involves the *extremely unlikely* rearrangement of an entire room of TRU waste containers resulting from a flammable gas explosion leading to a criticality Each of these bounding scenarios are further defined in the following discussions

5.8.1.1 Facility Structural Failure Induced Criticality Scenario Development and Selection

The Building 991 Complex has many areas identified for the storage of TRU waste and POC containers (*Hazard/Energy Source 4B*) The criticality scenario being evaluated is a result of a structural failure due to collapse of a tunnel (Tunnel Degradation and Leakage, *Hazard/Energy Source 13C*) or due to failure of the flooring (Floor Loading, *Hazard/Energy Source 13E*) The spill accident analysis in Section 5 4 1 2, *Facility Structural Failure Spill Scenario Development and Selection*, identified a requirement that ***storage of waste containers in Corridor C is prohibited***, Requirement R19 Since Corridor C is the only tunnel area currently believed to be susceptible to degradation and subsequent collapse, imposing Requirement R19 eliminates the criticality scenarios dealing with collapse of a tunnel

The failure of the flooring (which can lead to a criticality) is also addressed in the spill accident analysis in Section 5 4 1 2, *Facility Structural Failure Spill Scenario Development and Selection* As indicated in the spill analysis, the Room 153 hallway running from east to west in the north waste storage areas may be used to store up to approximately 100 drums The fissile gram equivalent radioactive material inventory of the 100 drums would be 20,000 grams using the ***container fissionable material loading*** assumption in General Assumption G12 Assumption A9 indicates that at least 10,000 grams of plutonium oxide is required to yield a criticality involving waste material (Ref 32) Therefore, the entire hallway inventory exceeds the fissionable material threshold for a criticality and requires further analysis, as provided below

The criticality event due to a floor collapse is postulated to occur as a result of a combination of (1) container breaches freeing fissionable material for collection, (2) flooding due to the rupture of piping in the basement corridors following floor collapse, and (3) collection of the freed fissionable material by the flood waters into a critical configuration The basis behind Assumption A9 indicates that more than 10,000 grams of plutonium oxide containing no more than 1 5 wt% water, at full density, and reflected by an effectively infinite thickness of water is required to achieve a criticality If the plutonium oxide remained "dry" during the flooding event and was just surrounded by water, the application of this assumption would be

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appropriate However, the flooding event following container breach can produce a slurry of plutonium with a more appropriate limit to criticality of 450 grams It is assumed that the potential exists for breached container inventories to be carried by the flood water into a slurry configuration in the basement

The evaluated floor collapse scenario assumes that the waste containers brought into the complex meet ***metal waste container*** specifications, therefore, the number of actual breaches of containers due to structural impact from the floor collapse are reduced due to the strength of the containers The number of waste containers that could potentially be involved in the accident is the total inventory in the hallway (*i e*, approximately 100 drums). The drums stored in the hallway will be separated in groupings of drums so as not to block doorways and other openings Assuming that all 100 drums are in one location is a conservative assumption It is also considered conservative to assume that a total collapse of the floor occurs if the floor loading requirements are exceeded Of the total number of drums involved in the accident, it is estimated that approximately 10% of these drums are damaged and breached to a point where a radioactive material exposure to flood waters can occur (consistent with the assumptions presented in Section 5 4 1 2, *Facility Structural Failure Spill Scenario Development and Selection*) If a container is breached, it is conservatively assumed that 100% of the fissionable material in the container is impacted by the flood water Therefore, based upon these assumptions, the potential amount of fissionable material available for collection in this scenario is 2,000 grams (100 drums x 200 grams/drum x 10% DR x 100% material available for collection). This quantity of material exceeds the 450 grams of plutonium threshold for a criticality However, the assumption that 100% of the radioactive material in the breached container exits the container and collects into a critical configuration does not account for numerous mechanisms that can keep the material on the contaminated surface or in the container

It is difficult to determine how much of the 2,000 grams of plutonium can migrate from breached containers to a single location The single location could be created as a "pool" area amongst the floor collapse rubble that would support a critical configuration or could be the basement drainage system (*i e*, sanitary waste system)

Section 5 4 1 2, *Facility Structural Failure Spill Scenario Development and Selection*, indicated that breaching of POC containers due to floor collapse scenarios is a *beyond extremely unlikely* event Therefore, the only form of material involved in the potential criticality comes from contaminated wastes TRU waste materials can range from contaminated metal parts to contaminated paper products The radioactive material component of the TRU waste can range from loose surface contamination to fixed contamination to material trapped in a solid matrix (*e g*, cemented wastes, micro-encapsulated wastes) The actual waste material could be directly exposed to the water spray from the broken pipe, could be impacted by water as it rises in rubble, or could be located away from any water impact Given all these variables, it is conservatively assumed that the radioactive material component of the breached container wastes has a "collection" release fraction of 0 1 This "collection" release fraction is the amount of material from the breached containers that is impacted by the water and enters into solution to be carried to the "pool" area in the rubble or to the drainage system

The collection release fraction of 0 1 is equivalent to the ARF value associated with the container explosion scenario The energy involved in the venting of pressurized gases over unyielding, contaminated surfaces is significantly more than the energy associated with contaminated surface exposure to water spray or rising water Therefore, the energy acting on the contaminated materials from the flooding event would be conservatively bounded by using an ARF value for a higher energy scenario However, this argument does not account for the entry of contamination into solution (*i e*, chemical action rather than physical action) The justification for and conservatism associated with the 0 1 collection release fraction in a flooding situation is as follows

- some of the radioactive material will be trapped in a solid matrix that is not susceptible to impacts by water (*i e*, contamination remains in matrix),
- some of the radioactive material will be fixed surface contamination that will have a small collection release fraction when exposed to a water stream and an even smaller collection release fraction when exposed to slow moving water that is rising around the container (*i e*, contamination remains on exposed surface),
- some of the radioactive material will be loose surface contamination that will enter into solution but not leave the confines of the container due to the configuration of plastic bagging and orientation of the container (*i e*, breach in container is oriented up, contamination enters solution but collects in the bottom of the container, contamination remains in breached container),
- some of the radioactive material is not in the water spray and is above the level where water can impact due to the container being on top of the rubble or other containers (*i e*, exposed contamination does not enter into solution), and
- some of the radioactive material that enters into solution will be collected in numerous potential pool area due to the configuration of the rubble rather than collected in any single pool area of the drainage system (*i e*, contamination is dispersed)

Applying a 0 1 collection release fraction to the 2,000 grams of fissionable material exposed by the breaching of waste containers conservatively yields a total of 200 grams of fissionable material that could migrate into a single location during the flooding event This quantity of plutonium is below the 450 gram threshold for a criticality Therefore, the floor collapse scenario leading to a breach of waste containers and flooding by broken water piping in the basement is not expected to lead to a criticality (*i e*, it is considered a *beyond extremely unlikely* event) and does not require further analysis

5 8 1.2 Flammable Gas Explosion Induced Criticality Scenario Development and Selection

The Building 991 Complex has many areas identified for the storage of TRU waste containers (*Hazard/Energy Source 4B*) The criticality scenario being evaluated is a result of an explosion of flammable gas (Propane, *Hazard/Energy Source 5B*, or Natural Gas, *Hazard/Energy Source 5C*) impacting a set of TRU waste containers The propane hazard was intended to represent any of a number of flammable gases that may be used in the Building 991 Complex Acetylene gas was used in the evaluation of the propane hazard and poses similar, if not greater, risks to the facility than the use of propane due to the explosive yield of acetylene being greater than that for equivalent quantities of propane

The natural gas hazard was addressed in Section 5 7 1, *Facility Explosion Scenario Development and Selection* A requirement that the Room 166 glass pane ***window must be covered or eliminated*** was defined to reduce the likelihood that the natural gas hazard can impact waste storage areas to a *beyond extremely unlikely* event An alternative control was defined to ***restrict Room 166 storage to POC containers*** Due to the difficulty in assuring/confirming that the window covering does provide the desired protection, only the ***restrict Room 166 storage to POC containers*** control is actually credited POC containers were excluded from further evaluation in explosion scenarios based on crediting Feature F9, which state that POC containers cannot be breached by any external flammable gas explosions expected during facility operation This requirements also reduces the likelihood of a natural gas explosion in Room 166 impacting POC containers to a *beyond extremely unlikely* event

Therefore, the propane (or acetylene) hazard is the only flammable gas hazard remaining that could initiate a series of events leading to a criticality The facility explosion accident analysis in Section 5 7 2, *Facility Explosion Scenario 1 - Explosion in Waste Container Storage Area*, identified a requirement that ***use of acetylene in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited***, Requirement R23 This requirement addresses acetylene explosion events in rooms with volumes small enough to result in an overpressure of 22 psig (*i e*, waste drum overpressure failure criteria) Imposing this requirement assures that flammable gas explosions cannot result in overpressure failures of containers The mechanism identified for container breach following a facility explosion was the impact of debris from room ceiling equipment, dislodged by the explosion, penetrating waste containers within the room A conservative MAR of 10 TRU waste drums was selected for this facility explosion scenario analysis This MAR selection is consistent with the approach taken in the Building 371/374 BIO (Ref 30) but is much more conservative than the approach taken in the evaluation of the seismic hazard in this document (see Section 5 9, *Natural Phenomena and External Event Scenario Accident Analyses*)

Therefore, it is conservatively assumed that a facility explosion involving acetylene or propane flammable gas cylinders breaches 10 TRU waste drums The fissile gram equivalent radioactive material inventory of the 10 drums would be 2000 grams using the ***container fissionable material loading*** assumption in General Assumption G12 Assumption A9 indicates that at least 10,000 grams of plutonium oxide is required to yield a criticality involving waste material Therefore, it would appear that a facility explosion cannot yield a criticality due to MAR limitations However, the facility explosion could set off the automatic sprinkler system that would add water to the fissionable material and lower the criticality threshold for the accident to 450 grams as discussed in Section 5 8 1 1, *Facility Structural Failure Induced Criticality Scenario Development and Selection*

The criticality event due to a facility explosion is postulated to occur as a result of a combination of (1) container breaches freeing fissionable material for collection, (2) "flooding" due to the actuation of the automatic sprinkler system, and (3) collection of the freed fissionable material by the sprinkler waters into a critical configuration The flooding event following container breach can produce a slurry of plutonium with a more appropriate limit to criticality of 450 grams It is assumed that the potential exists for breached container inventories to be carried by the sprinkler water into a slurry configuration However, the assumption that 100% of the radioactive material in the breached container exits the container and collects into a critical configuration does not account for numerous mechanisms that can keep the material on the contaminated surface or in the container

It is difficult to determine how much of the 2,000 grams of plutonium can migrate from breached containers to a single location The single location for collection of the fissionable material could be the facility drainage system (*i e*, sanitary waste system)

The only form of material involved in the potential criticality comes from contaminated wastes TRU waste materials can range from contaminated metal parts to contaminated paper products The radioactive material component of the TRU waste can range from loose surface contamination to fixed contamination to material trapped in a solid matrix (*e g*, cemented wastes, micro-encapsulated wastes) The actual waste material could be directly exposed to the water spray from the sprinklers or could be located away from any significant water impact by being sheltered in the waste container Given all these variables, it is conservatively assumed that the radioactive material component of the breached container wastes has a "collection" release fraction of 0 1 This "collection" release fraction is the amount of material from the breached containers that is impacted by the water and enters into solution to be carried to the drainage system

The collection release fraction of 0 1 is equivalent to the ARF value associated with the container explosion scenario The energy involved in the venting of pressurized gases over unyielding, contaminated surfaces is significantly more than the energy associated with contaminated surface exposure to water spray or rising water in a container Therefore, the energy acting on the contaminated materials from the sprinkler actuation event would be conservatively bounded by using an ARF value for a higher energy scenario However, this argument does not account for the entry of contamination into solution (*i e*, chemical action rather than physical action) The justification for and conservatism associated with the 0 1 collection release fraction in a water spray situation is as follows

- some of the radioactive material will be trapped in a solid matrix that is not susceptible to impacts by water (*i e*, contamination remains in matrix),
- some of the radioactive material will be fixed surface contamination that will have a small collection release fraction when exposed to a water stream and an even smaller collection release fraction when exposed to slow moving water that is rising inside the container (*i e*, contamination remains on exposed surface),

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Table 102 Assumptions/Features/Requirements for Criticality Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A3	Damaging tunnel failure and floor loading failures are *unlikely* events, damaging aircraft crashes are *extremely unlikely* events	B-CRIT-1	Sets the likelihood of some internal and external events
A4	Natural gas system failure leading to an explosion impacting the facility is an *extremely unlikely* event	B-CRIT-2	Sets the likelihood for facility explosion events
A9	At least 10 kilograms of plutonium oxide is required to yield a criticality involving waste material	B-CRIT-1 B-CRIT-2	Reduces the likelihood of criticalities from scenarios dealing with less than 10 kilograms of plutonium contaminated waste to *Beyond Extremely Unlikely*
A22	No more than 10% of contaminated waste fissionable material in breached waste containers will migrate out of containers and into solution in scenarios involving flooding or sprinkler actuation	B-CRIT-1 B-CRIT-2	Reduces the amount of material that can be collected in criticality scenarios involving breached containers and water
F6	Type B shipping containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	B-CRIT-1	Reduces the likelihood of Type B shipping container failure for scenarios dealing with structural members impacting containers by one frequency bin ***Type B Shipping Container***
F7	POC containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	B-CRIT-1	Reduces the likelihood of POC container failure for scenarios dealing with structural members impacting containers by one frequency bin ***POC Container***
F9	POC containers cannot be breached by any external flammable gas explosions expected during operation	B-CRIT-2	Reduces the likelihood of POC container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely* ***POC Container***

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Table 102 Assumptions/Features/Requirements for Criticality Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F17	Flammable gas containers are *unlikely* to be breached during use	B-CRIT-2	Reduces the likelihood of explosion or fire scenarios due to use of flammable gases by one frequency bin ***Flammable Gas Container***
F28	Metal waste containers cannot be breached by falls less than four feet	B-CRIT-1	Reduces the likelihood of metal waste container failure due to dropping from less than four feet to *Beyond Extremely Unlikely* ***Metal Waste Container***
F29	Metal waste drums cannot be breached by an external explosion peak overpressure less than 22 psig	B-CRIT-2	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Metal Waste Drum***
R9	A hot work control program shall be implemented to make flammable gas explosions in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	B-CRIT-2	Reduces the likelihood of facility explosions potentially impacting radioactive material by one frequency bin ***Hot Work Control***
R19	Storage of waste containers in Corridor C is prohibited	B-CRIT-1	Eliminated analysis of structural failure of the corridor and its potential impact on the MOI, CW, and IW ***Storage of Waste Containers in Corridor C Prohibited***
R23	The use of flammable gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited	B-CRIT-2	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Use of Flammable Gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is Prohibited***

Table 102 Assumptions/Features/Requirements for Criticality Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R24	The flammable gas inventory in Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, and Building 998 shall be limited to 150 ft^3	B-CRIT-2	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Flammable Gas Inventory***
R25	The glass pane window in Room 166 shall be covered or eliminated	B-CRIT-2	Reduces the likelihood of gas getting into Room 166 with a subsequent gas explosion that can impact waste containers stored in the room to a *beyond extremely unlikely* event Superceded by Room 166 Waste Storage Restrictions [R26]
R26	Room 166 can only be used to store POC containers, metal waste containers other than POC containers are prohibited from storage in Room 166	B-CRIT-2	In combination with ***POC container***, reduces the likelihood of a natural gas explosion in Room 166 impacting radioactive material to a *Beyond Extremely Unlikely* event ***Restrict Room 166 Storage to POC Containers***

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5.9 NATURAL PHENOMENA AND EXTERNAL EVENT SCENARIO ACCIDENT ANALYSES

5.9.1 Natural Phenomena and External Event Scenario Development and Selection

5.9.1.1 Natural Phenomena Scenario Development and Selection

The natural phenomena hazards (NPHs) of concern at the Site and to the Building 991 Complex were identified in the hazard evaluation process and discussed in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination* The NPHs that were identified are (1) seismic events (earthquakes), (2) lightning, (3) high winds and tornadoes, (4) heavy rain, flooding, and freezing events, and (5) heavy snow DOE Order 5480.28, *Natural Phenomena Hazards Mitigation* (Ref 44) establishes the policy and requirements for NPH mitigation for DOE sites and facilities Guidance addressing NPHs is provided in several DOE Standards DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (Ref 45), DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Criteria for Structures, Systems, and Components* (Ref 46), DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria* (Ref 47), DOE-STD-1023-94, *Natural Phenomena Hazards Assessment Criteria* (Ref 48), DOE-STD-1024-92, *Guidelines for Use of Probabilistic Seismic Hazard Curves at DOE Sites* (Ref 49), and draft standard entitled *Lightning Hazard Management Guide for DOE Facilities* (Ref 50) Each of the NPHs identified in the hazard evaluation process will be addressed in the following sub-sections

5.9.1.1.1 Seismic Events

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, seismic events have the potential to initiate (1) *unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving LLW and TRU waste containers, (3) *extremely unlikely* spill scenarios involving POC and Type B shipping containers, (4) *unlikely* puncture scenarios involving LLW and TRU waste containers, (5) *extremely unlikely* puncture scenarios involving POC and Type B shipping containers, (6) *extremely unlikely* facility explosion scenarios involving LLW and TRU waste containers, (7) *unlikely* criticality scenarios involving TRU waste containers, and (8) *extremely unlikely* criticality scenarios involving TRU waste, POC, and Type B shipping containers These frequencies are conservative estimates as determined in the hazard evaluation and are further refined in the following discussions

The *extremely unlikely* spill, *extremely unlikely* puncture, and *extremely unlikely* criticality scenarios dealing with Type B shipping containers all involve breaches of the container (Requirement R4 precludes a criticality of a Type B shipping container as long as the containers remain intact) Type B shipping containers are assumed to be vulnerable to the same failure mechanisms as a POC container That is, the containers are vulnerable to focused penetration energy (*e g* , forklift tine, structural member) at the side of the containers The container integrity is not vulnerable to crushing mechanisms (*e g*, ceiling collapse onto an up-right container) Given that Type B shipping containers are only staged in vaults (General Assumption G8), which eliminates any vulnerability to their falling through the floor, and given that Type B shipping containers are not permitted to be stacked (Requirement R1), which eliminates any vulnerability to seismic induced toppling, the vulnerable sides of the Type B shipping containers will not be exposed to structural member impacts following the seismic event Therefore, the likelihood of a Type B shipping container breach following a seismic event is considered to be *beyond extremely unlikely* and will not be further analyzed

Facility fires following a seismic event may occur, particularly in areas of the complex with significant combustible loading in close proximity to electrical equipment The likelihood of a fire being initiated in a waste storage area in the complex is considered to be *beyond extremely unlikely* due to the combustible material control program (Requirement R8), which restricts combustible loading and ignition sources in waste storage areas Fires are considered to be credible in the Office Area, utility rooms, and auxiliary buildings (*e g*, diesel generator building) The seismic event is very likely to breach the fire barriers between these susceptible areas and the waste storage areas However, the breach of the facility will permit hot gases from the fire to exit the facility rather than to migrate over to waste storage areas The most susceptible waste storage area is the West Dock Canopy Area containing multiple LLW crates Facility Fire Scenario 4 evaluated a fire involving this material and the MOI and the CW radiological dose consequences were both in the *low* consequence bin The contribution of this type of fire to the overall seismic event consequences is very small (see NPH/EE Scenario 1 which evaluates seismic-induced spill yielding *high* consequences to the CW and *moderate* consequences to the MOI) Therefore, the contribution of facility fire scenarios to releases associated with seismic events is considered to be small compared to the releases due to spills

The likelihood of criticality scenarios following a seismic event are not expected to be any higher than those associated with the floor collapse scenario discussed in Section 5 8, *Criticality Scenario Accident Analyses* While more containers may be breached in the seismic event, the necessary contribution of water to the debris can only occur in a limited number of locations (*i e*, a breach of a water line will cut off all water to other lines downstream) Therefore, the criticality scenario following a seismic event is considered to be a *beyond extremely unlikely* event and will not be further evaluated

The likelihood of seismic-induced facility explosions is initially estimated to be *extremely unlikely* as compared to the *unlikely* breach of containers due to structural member impacts and stack toppling The facility explosion would impact the containers in a similar fashion but with much lower likelihood For this reason, the contribution of facility explosions to the overall spill consequences following a seismic event is considered to be small and will not be further evaluated

Therefore, an earthquake is credible and considered to result in a spill scenario as evaluated in this section A review of past studies of the structural adequacy of Building 991 was performed to determine the building capacity in accordance with the seismic probability curves in the 1994 Seismic Hazard Analysis (Ref 51) This analysis indicates that the design basis earthquake (DBE) for Building 991 has an occurrence frequency of 8 11 x 10^{-4}/yr (annual recurrence of mean confinement earthquake is 1,233 years) with a peak ground acceleration of 0 09 g Thus, a DBE is considered an *unlikely* event

Based on the *FSAR Review Team Report on Rocky Flats Plant Building 707*, (Ref 52) it is not expected that stacks of boxes or drums will fall under ground accelerations below 0.3 g, unless the earthquake collapses the structure The minimum peak velocity imparted by an earthquake needed to topple the stack is approximately 51 inches per second or an acceleration of about 0 33 g (Ref 52) The peak velocities listed for earthquakes of 0 08 g to 0 21 g range from 0 5 inches per second to 4 4 inches per second, much less than that required to topple a stack Since the DBE for the Building 991 Complex is 0 09 g, no waste container damage from toppling stacks is expected to occur during the DBE or lesser earthquakes Some collateral damage (i e , non-seismically rated equipment impacting waste containers) could be expected

The review of the structural adequacy of Building 991 indicated that structural failure of the building (i e , a Beyond Design Basis Earthquake (BDBE) event), has an occurrence frequency of 3 0 x 10^{-4}/yr (annual recurrence of mean collapse earthquake estimated at 3,333 years) Thus, a BDBE is considered an *unlikely* event The BDBE event is estimated to have a peak ground acceleration at bedrock of 0 16 g and is assumed to cause structural damage and partial collapse of the building structure The number of waste containers estimated to be damaged by a BDBE is based on the number of containers that would be exposed to absorb the impact of falling objects Additionally, damage to containers may result from a BDBE with intensity greater than 0 33 g causing drums to tip over Reference 51 indicates that it is possible that Building 991 could be qualified to Performance Category 3 by DOE-STD-1020 if an engineering analysis to the criteria in that standard were performed This would require structural detailing and connections to be checked for seismic capability Since it cannot be conclusively stated that Building 991 meets Performance Category 3, the BDBE event will be analyzed along with the DBE event

The selected seismic event scenarios evaluated for the Building 991 Complex are

NPH/EE Scenario 1 - DBE Event-Induced Spill: This scenario involves a DBE resulting in damage to overhead equipment and material that is not seismically rated This results in damage to waste containers in the facility The DBE is an *unlikely* event

NPH/EE Scenario 2 – BDBE Event-Induced Spill: This scenario involves a beyond DBE resulting in structural damage and collapse of the building and toppling of stacked containers This scenario is also an *unlikely* event and the damage to waste containers will bound all other NPH events that are considered credible for the Building 991 Complex

5.9.1 1.2 Lightning

Lightning is considered a potential ignition source for facility fire, facility explosion, and criticality (due to facility explosion) scenarios Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, lightning events have the potential to initiate (1) *unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* facility explosion scenarios involving LLW and TRU waste containers, and (3) *extremely unlikely* criticality scenarios involving TRU waste containers These frequencies are conservative estimates as determined in the hazard evaluation and are further refined in the following discussions

The facility explosion and criticality scenarios following lightning events are considered to be *beyond extremely unlikely* events based on the discussions in Section 5 7, *Facility Explosion Scenario Accident Analyses*, and Section 5 8, *Criticality Scenario Accident Analyses* These discussions indicated that numerous failures must occur in conjunction with specific facility configurations for these events to be realized The likelihood of a lightning strike hitting the specific location associated with the facility configuration to lead to a facility explosion that can impact waste storage areas is remote The configurations necessary to achieve a criticality were already dismissed as *beyond extremely unlikely* events with major facility impact events Lightning is not expected to yield events as significant as a floor collapse under a waste storage area Therefore, the lightning event is only evaluated for a potential contribution to facility fires

The building is equipped with a perimeter lightning protection system that includes a lightning protection loop with air terminals mounted on the perimeter of the roof The lightning protection system is intended to reduce the probability that lightning strikes will result in damage to building systems or initiate a fire However, the condition of the lightning protection system is not known, and although there is no reason to believe the system is inoperable, it is not credited to provide protection against lightning strikes The frequency of a lightning occurrence is estimated at 8×10^{-3}/yr based on information in Ref 8 making this an *unlikely* event If a lightning strike occurs initiating a building fire, the scenario is considered bounded by the internal event fires presented in Section 4 5 3, *Facility Fire Scenario Accident Analyses*

5.9.1.1.3 High Winds and Tornadoes

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, high wind events have the potential to initiate (1) *anticipated* spill scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving POC containers, (3) *anticipated* puncture scenarios involving LLW and TRU waste containers, (4) *unlikely* puncture scenarios involving POC containers, (5) *anticipated* criticality scenarios involving TRU waste containers, (6) *unlikely* criticality scenarios involving POC containers, and (7) *extremely unlikely* criticality scenarios involving Type B shipping containers These frequencies are conservative estimates as determined in the hazard evaluation and are further refined in the following discussions

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, tornado events have the potential to initiate (1) *unlikely* spill scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* spill scenarios involving POC containers, (3) *unlikely* puncture scenarios involving LLW and TRU waste containers, (4) *extremely unlikely* puncture scenarios involving POC containers, (5) *unlikely* criticality scenarios involving TRU waste containers, and (6) *extremely unlikely* criticality scenarios involving POC and Type B shipping containers These frequencies are conservative estimates as determined in the hazard evaluation and are further refined in the following discussions

High winds and tornadoes have similar, but lesser, impacts on the facility as compared to seismic events For this reason and the reasons presented in Section 5 9 1 1 1, *Seismic Events*, high wind- or tornado-induced criticality scenarios are not considered further

Upon further investigation, destructive tornadoes are considered *beyond extremely unlikely* for the Site (Ref 53) The location of the Site near the Front Range of the Rocky Mountains places the complex in a "special wind area" as defined by building codes The reason for this is that certain weather conditions lead to extremely high winds of fairly frequent occurrence However, the location is westerly enough so tornado occurrence has a lower probability A reassessment of tornado and straight winds was performed by McDonald-Mehta Engineers in 1995 (Ref 54), resulting in updated hazard curves The reassessment showed that for exceedance probabilities greater than 10^{-7}/yr, straight wind clearly dominates the Site hazard However, the reassessment indicated that atmospheric pressure change (APC) due to tornadoes and wind generated missiles should be evaluated

A report generated by Agbabian Associates (Ref 55) indicates that the maximum allowable load level for wind for Building 991 is a peak gust of 96 mph The McDonald-Mehta report provides the following equation for converting from peak gust wind speeds to the fastest mile wind speeds that are used in the DOE 1020 Standard series

$$V_{fm} = 0\ 958 \bullet V_{pg} - 11\ 34$$

Converting the 96 mph peak gust results in an 81 mph fastest mile wind being the maximum allowable load for Building 991 However this is wind speed at Building 991 The DOE Standards require measurement at 10 meters The Site's 10 meter tower is located northwest of the industrial area and has recorded a gust of 127 mph (110 mph fastest mile) (Ref 54) The measured wind speed at the tower must be converted to wind speed at the building for comparison to the 96 mph limit using the following formula (Ref 56)

$$V = V_{10m} \bullet (h/10)^p$$

Where

V_{10m} is the wind speed at the 10 meter tower

h is the height of the building in meters

p is a value based on the atmospheric stability class and location according to Table 103

Table 103 Values of p for Tower Wind Speed Conversions

	STABILITY CLASS					
	A	B	C	D	E	F
URBAN	0 15	0 15	0 20	0 25	0 40	0 60
RURAL	0 07	0 07	0 10	0 15	0 35	0 55

Discussion with experienced meteorologists indicates that Building 991 can be considered ground level, however, a value of $h = 0$ does not give a valid result when used in the above formula Furthermore, the discussion indicated that the p value corresponding to Urban, Stability Class D should be used By using the values $V_{10m} = 127$ mph, $h = 1$ m, and $p = 0\ 25$, it is determined that the 127 mph peak gust recorded at the tower was a gust of 71 mph at Building 991 The formula can be rearranged to solve for the wind speed at the tower if the wind speed at the building is known This is desirable for comparison to the wind speeds for various Performance Categories presented in the McDonald-Mehta report Since the DOE standards use fastest mile speeds for comparison, a value of $V = 81$ mph will be used By using the values $V = 81$ mph, $h = 1$ m, and $p = 0\ 25$, it is determined that the maximum allowable load is a fastest mile wind speed of 144 mph measured at 10 meters The 144 mph fastest mile wind speed corresponds to a peak gust of 162 mph The McDonald-Mehta report indicates that the Performance Category 3 (PC-3) fastest mile straight wind design wind speed is 139 mph, thus Building 991 exceeds the PC-3 criteria

An alternate approach for evaluating the wind loads on the Building 991 structure has also been developed (Ref. 57) This alternate approach indicates that the fastest mile wind speed that the Building 991 structure could withstand is 162 mph The McDonald-Mehta report indicates that the PC-4 fastest mile straight wind design speed is 161 mph, thus Building 991 would meet the PC-4 criteria if the alternate approach is used

Since most of the building was designed to withstand the overpressure associated with the blast of a 2,000 pound bomb, it is expected that with the exception of Room 166 and Room 170 all waste storage areas are unaffected by APC The damage to waste containers within Room 166 and Room 170 would occur, similar to the earthquake initiated spill, due to impact by falling structural components of the building The frequency and consequence of the earthquake initiated spill scenario, *NPH/EE Scenario 2 – BDBE Event-Induced Spill,* bounds APC initiated spills because the earthquake has a greater potential to involve more material and has a lower capability to disperse the release than an APC scenario

DOE-STD-1020-94 provides characteristics of wind missiles to be considered and recommended missile barriers The only waste storage areas the timber plank missile is assumed to penetrate are Room 166 and Room 170, since all other areas are protected by at least 8 inch reinforced concrete walls and at least 4 inch reinforced concrete roofs The steel pipe missile additionally penetrates the waste storage area in Room 134 since the roof is only 4 inch reinforced concrete All other wastes storage areas are protected by at least 12 inch reinforced concrete walls and 12 inch reinforced concrete roofs The damage to waste containers within the building would occur due to impact by the missile and would impact relatively few containers before all the energy associated with the missile was spent The frequency and consequence of either earthquake initiated spill scenario, *NPH/EE Scenario 1 - DBE Event-Induced Spill or NPH/EE Scenario 2 – BDBE Event-Induced Spill,* bounds wind missile initiated spills because the earthquake has a greater potential to involve more material and has a lower capability to disperse the release than a wind missile scenario

Tornado and high wind events are not further analyzed

5.9.1.1.4 Heavy Rain, Flooding, and Freezing

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, heavy rain events do not have a credible potential to initiate any scenarios, flooding events do not have a credible potential to initiate any scenarios, and freezing events do not have a credible potential to initiate any scenarios (flooding scenarios have little impact due to lack of contamination) The likelihood of these initiating events is further evaluated for completeness of the Safety Analysis, even though the event impacts are minimal

DOE-STD-1020-94 requires selection of a design basis flood (DBFL) based on a probabilistic flood hazard assessment as described in DOE-STD-1023-95 The *Rocky Flats Plant Drainage and Flood Control Master Plan* (Ref 58) does not meet DOE-STD-1023-95 requirements, but is the best analysis the Site has The Plan analyzed 25-and 100-year events, and determined that the area around Building 991 was susceptible to flooding during 10- and 25-year events The transformer, Building 989, and Building 984 are vulnerable during 10-year events, while the southeast stairwell to the basement and the West Dock Canopy Area are vulnerable during 25-year events Further analysis was later performed for 2-, 5-, 10-, and 500-year events (Ref 59)

DOE-STD-1020-94 requires consideration of several different flood events and combinations of events The combinations are presented in Table 104 below

Table 104 Design Basis Flood Events

PRIMARY HAZARD	EVENT COMBINATIONS AND DISCUSSION
River Flooding	Not applicable since no rivers are near the Site
Dam Failure	Not applicable since no dams are above drainage areas into the Site.
Local Precipitation	Runoff Flooding Applicable, discussed below Ponding Applicable, discussed below Rain and Snow Applicable, discussed below
Storm Surge, Seiche	Not applicable since no large bodies of water are near the Site
Levee or Dike Failure	Not applicable since no levees or dikes are above drainage areas into the Site
Snow	Applicable, discussed below
Tsunami	Not applicable since no oceans are near the Site

Runoff Flooding The 1st floor elevation of Building 991 is 5,935 feet The elevation of the 500-year flood is 5,933 1 feet Discussion with Surface Water Group personnel indicates that even a 10,000-year flood level would be below the 1st floor level However, Building 996 is approximately 1 foot lower than the 1st floor, although still 8 inches above the 500-year level, and may be more susceptible to flooding If 1 foot of water (1st floor level) got into the Building 996 waste storage areas no adverse impacts to MAR are expected Runoff flooding is not discussed further

Ponding If the primary roof drains are blocked, secondary drainage will occur at a height of 12 inches above the roof over the parapets Since one cubic foot of water weighs 62 43 pounds, this corresponds to a loading of 62 43 psf The roof was designed to be capable of supporting a load of 35 psf, which corresponds to a water depth of 6 73 inches

Rain data from the Site SAR (Ref 53) was extrapolated by using Microsoft Excel to generate a trend-line that corresponded to the data The equation of the trend-line was then used to calculate the extrapolated frequencies for larger rain events The extrapolation is provided in Figure 17

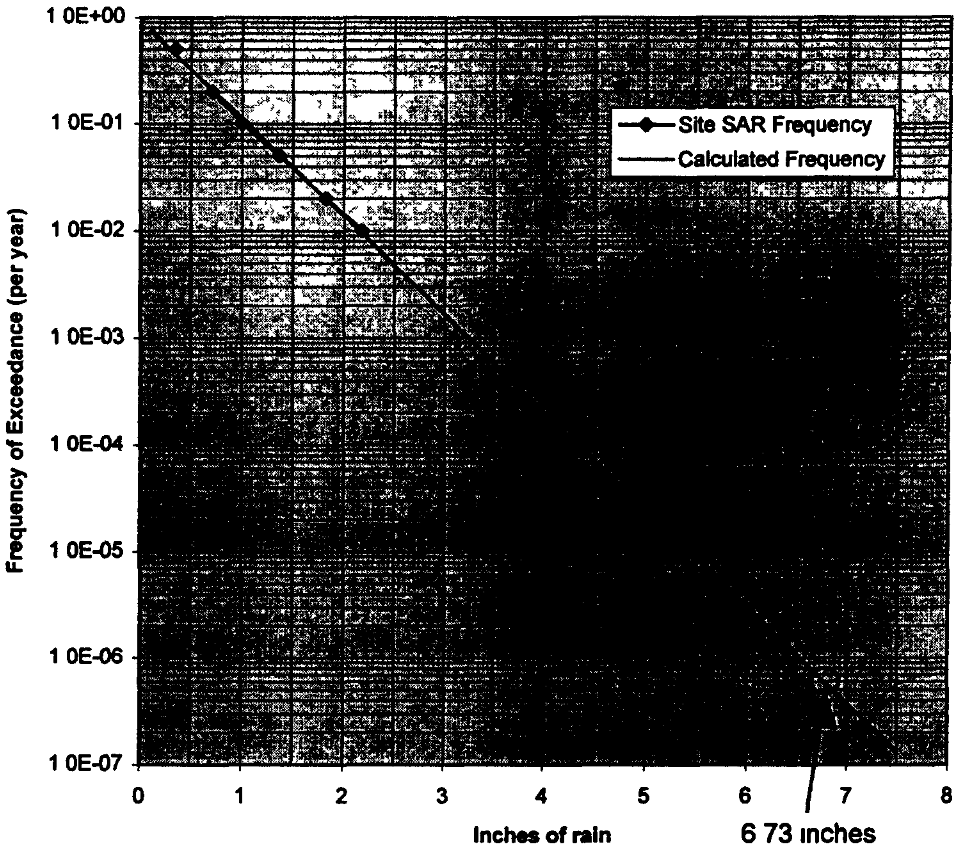

Figure 17 Frequencies for Heavy Rains Based on Site Data

The frequency of exceedance for 6 73 inches of rain in a 24-hour period is shown to be less than 10^{-6}/yr Thus even if all roof drains are plugged, the probability of roof failure and release of radioactive material is *beyond extremely unlikely* Ponding is not discussed further

Rain and Snow It is expected that the snow followed by rain event will be similar to and bounded by the snow event described below Typically this event would occur in the spring, and would not be accompanied by a hard freeze that would prevent the roof drains from working Rain and snow are not discussed further

5.9.1.1.5 Heavy Snow

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, heavy snow events have the potential to initiate (1) *anticipated* spill scenarios involving LLW and TRU waste containers, (2) *unlikely* spill scenarios involving POC containers, (3) *extremely unlikely* spill scenarios involving Type B shipping containers, (4) *anticipated* puncture scenarios involving LLW and TRU waste containers, (5) *unlikely* puncture scenarios involving POC containers, (6) *extremely unlikely* puncture scenarios

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involving Type B shipping containers, (7) *anticipated* criticality scenarios involving TRU waste containers, (8) *unlikely* criticality scenarios involving POC containers, and (9) *extremely unlikely* criticality scenarios involving Type B shipping containers These frequencies are conservative estimates as determined in the hazard evaluation and are further refined in the following discussions

The *extremely unlikely* spill, *extremely unlikely* puncture, and *extremely unlikely* criticality scenarios dealing with Type B shipping containers all involve breaches of the container (Requirement R4 precludes a criticality of a Type B shipping container as long as the containers remain intact) Type B shipping containers are assumed to be vulnerable to the same failure mechanisms as a POC container That is, the containers are vulnerable to focused penetration energy *(e g*, forklift tine, structural member) at the side of the containers The container integrity is not vulnerable to crushing mechanisms *(e g*, ceiling collapse onto an up-right container) Given that Type B shipping containers are only staged in vaults (General Assumption G8), which eliminates any vulnerability to ceiling collapse, the vulnerable sides of the Type B shipping containers will not be exposed to structural member impacts following the heavy snow event Therefore, the likelihood of a Type B shipping container breach following a heavy snow event is considered to be *beyond extremely unlikely* and will not be further analyzed

The likelihood of criticality scenarios following a heavy snow event are not expected to be any higher than those associated with the floor collapse scenario discussed in Section 5 8, *Criticality Scenario Accident Analyses* Therefore, the criticality scenario following a heavy snow event is considered to be a *beyond extremely unlikely* event and will not be further evaluated

A heavy snow-induced facility collapse is considered to be credible and results in a spill scenario as evaluated in this section As discussed above, the roof has been analyzed to be capable of supporting a load of 35 psf The Snow Booklet (Ref 60) indicates that snow density has a lognormal distribution and that the range of conversions is from 2 5 inches of snow = 1 inch of water to 100 inches of snow = 1 inch of water, with the majority of the results about 10 inches of snow = 1 inch of water Assuming 5 inches of snow = 1 inch of water is a sufficiently conservative conversion for use in determining roof failure. As discussed above, a 35 psf load corresponds to 6 73 inches of water or 33 7 inches of snow

Snow data from a calculation supporting the Site SAR (Ref 61) was extrapolated by using Microsoft Excel to generate a trend-line that corresponded to the data The equation of the trend-line was then used to calculate the extrapolated frequencies for larger snow events The extrapolation is provided in Figure 18

The frequency of exceedance for 33 7 inches of snow is shown to be less than 10^{-3}/yr in Figure 18 Thus, the probability of roof failure and release of radioactive material is *unlikely* The damage to waste containers would occur, similar to the earthquake initiated spill, due to impact by falling structural components of the building The number of waste containers estimated to be damaged by a heavy snow-induced roof collapse is based on the number of containers that would be exposed to absorb the impact of falling objects

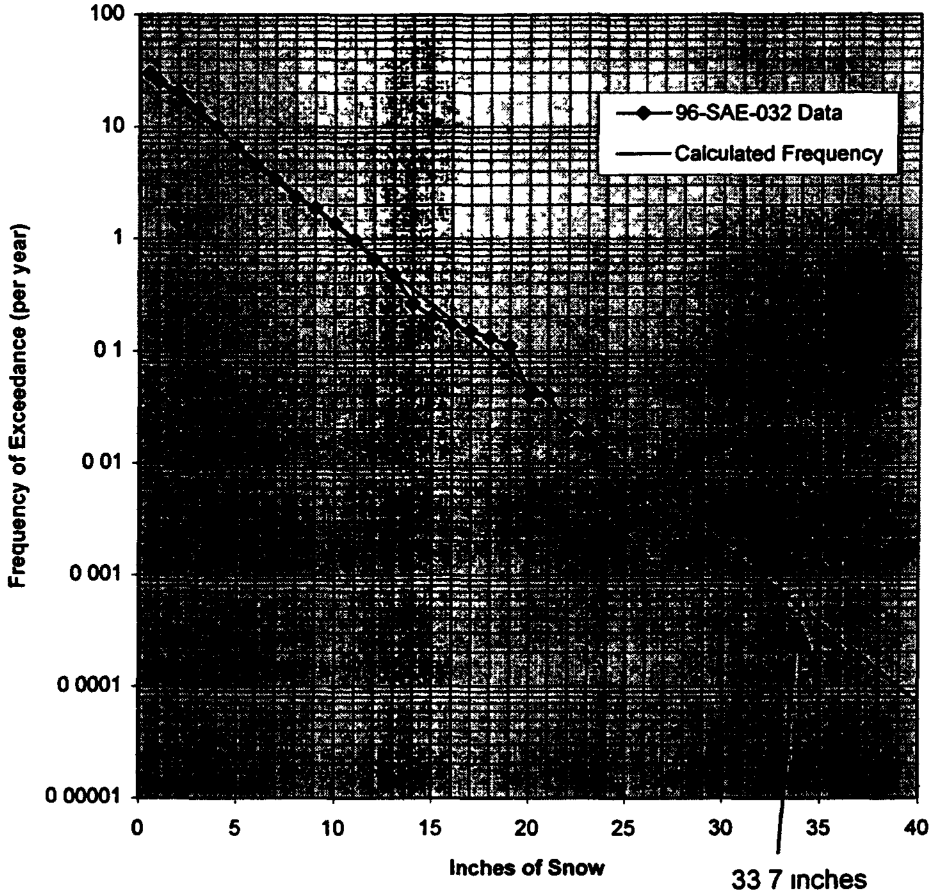

Figure 18 Frequencies for Heavy Snows Based on Site Data

The selected heavy snow event scenario evaluated for the Building 991 Complex is

NPH/EE Scenario 3 – Heavy Snow Event-Induced Spill: This scenario involves a heavy snow resulting in structural damage and collapse of the building This scenario is an *unlikely* event

5.9.1.2 External Event Scenario Development and Selection

5.9.1.2 1 Aircraft Crashes

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, aircraft crash events have the potential to initiate (1) *extremely unlikely* facility fire scenarios involving LLW and TRU waste containers, (2) *extremely unlikely* spill scenarios involving LLW and TRU waste containers, (3) *extremely unlikely* puncture scenarios involving LLW and TRU waste containers, and (4) *extremely unlikely* criticality scenarios involving TRU waste containers The actual aircraft crash frequency will be further evaluated to determine if any of these scenarios is credible

The frequency of occurrence for a small aircraft crash as a function of target area has been analyzed in Emergency Planning Technical Report, 97-EPTR-004, *Analysis of Aircraft Crash Accidents at the Rocky Flats Environmental Technology Site* (Ref 62) In terms of frequency, the greatest numbers of aircraft are represented by the small plane category associated with the Jefferson County Airport due to its operational volume and the closeness to the Site The crash of a large aircraft at the Site is screened out as a possibility in 97-EPTR-004 Denver International Airport and the J-60 Jet Route are also screened out from the analysis using the methodology of the DOE Standard on analysis of aircraft accidents (Ref 63), because the airport is more than 12 miles from the Site and the center of the jet route is more than six miles from the Site The technical report concluded the accident frequency involving Site facilities has been determined to be 7 67 x 10^{-4} accidents/square mile-year Using the methodology of the DOE Standard (Ref 63), the effective area for an aircraft crash was calculated and determined to be 4 00 x 10^{-3} square miles The Office Area was excluded when this area was determined Multiplying this frequency by the effective area of Building 991 results in a frequency of occurrence of 3 07 x 10^{-6} aircraft crashes/year This frequency is in the *extremely unlikely* frequency bin The DOE Standard directs consideration of "critical areas," possible impact approaches, and features that would act to limit the skid distance into the facility Perforation due to aircraft crash was considered in 97-EPTR-004 The conclusion was that Single, Twin, and Turboprop aircraft would not perforate structures with 12 inch reinforced concrete walls and 4 inch reinforced concrete roofs The only non-office areas of Building 991 that do not meet this criteria are Room 166 and Room 170 Room 166 is constructed of concrete block walls while the vulnerable west end of Room 170 is of steel beam and sheet metal construction The three categories of concern are grouped into a category called general aviation in the DOE standard A crash into each of these rooms was evaluated and the frequencies summed to determine if an aircraft crash could be screened out

Room 170 is conservatively estimated vulnerable in a 180° arc that approximates a diagonal from the northwest corner to the east dock door The skid distance was assumed to be 0 since the retaining wall west of the building would prevent skids from that direction and since the room is elevated from ground level, which would prevent skids from the southern direction When these factors, along with the room dimensions are considered, the resultant crash frequency is 5 44 x 10^{-7}/yr

Room 166 is conservatively estimated vulnerable in a 180° arc that approximates a diagonal from the northeast corner to the southwest corner The skid distance was assumed to be 0 feet since (1) the room is elevated from ground level, which would prevent skids from the south and east directions, (2) three large utility poles are directly east of the room, (3) Building 989, a concrete block building, is southeast of the room, and (4) wetlands, which reduce skid distance, are located east of the room When these factors, along with the room dimensions are considered, the resultant crash frequency is 2 96 x 10^{-7}/yr

The sum of the crash frequencies for both rooms is 8 36 x 10^{-7}/yr , which is less than the 1 00 x 10^{-6}/yr screening criteria of the DOE Standard Therefore, aircraft crashes into the vulnerable TRU waste storage areas of Building 991 are not evaluated further

5 9.1.2.2 Range Fires

Based on the discussions in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, range fire events have the potential to initiate (1) *extremely unlikely* facility fire scenarios involving LLW and TRU waste containers

Range fires were considered but not evaluated further because of insignificant radiological consequences Range fires have occurred on and near the Site, but are not expected to challenge the Building 991 Complex This is because the protected area boundary, roadways, and parking lots provide a substantial fire break and the Site Fire Department has adequate procedures and training to suppress a range fire on the Site

5 9.1.2.3 Station Blackout

Since the Building 991 Complex has no significant contamination or loose radioactive material (see Section 4 1 3, *Radioactive Materials (Hazard/Energy Source 4)*), no impact from a station blackout event is expected

Therefore, there are no external event scenarios evaluated for the Building 991 Complex

5 9.2 NPH/EE Scenario 1 – DBE Event-Induced Spill

This accident scenario is discussed below and is summarized in Table 106 located at the end of Section 5 9, *Natural Phenomena and External Event Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A DBE event is postulated to occur impacting the POC and TRU waste storage areas in the Building 991 Complex POC and TRU waste containers stored in Building 991 are considered to be susceptible to earthquake impacts Containers that are impacted may be breached by falling debris (e g , overhead cranes, heating, ventilating, and air conditioning (HVAC) ducts, etc) and other overhead equipment that is not seismically rated The building structure and roof is expected to remain intact in a DBE event and stacked waste containers are not expected to topple in a DBE event The exposed upper tier of waste containers is assumed to be susceptible to impact from the falling debris The breached containers from the falling debris do not spill the container contents from the breach since the breach is at the top or upper portion of the container Since the breaches do not result in radioactive material "flowing" from the breach, as is the case in the forklift tine puncture of containers (see Section 5 5, *Puncture Scenario Accident Analyses*), these container breaches are analyzed as a confined material releases A ground-level (non-lofted) release of the radioactive material is assumed The spill is a short duration event and a minimum duration release (10 minutes) is analyzed

POC and TRU waste containers stored in tunnels and vaults (*i e*, Building 996 and Building 998) are assumed to not be impacted by the DBE event (*i e*, no falling debris due to minimal overhead material) A concurrent fire, caused by the earthquake, is not considered due to the low combustible loading in the waste storage areas

Scenario Modeling Assumptions spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The likelihood of this postulated accident scenario is *unlikely* based on the review of the structural adequacy of the building (Ref 51) An occurrence frequency of a DBE event is estimated at 8 11 x 10^{-4}/yr As stated above, a concurrent fire with the DBE is considered *beyond extremely unlikely* due to the credited ***combustible material control*** program that limits the amount of combustibles in waste storage areas

Scenario Modeling Assumptions *unlikely* event

Material-At-Risk

The POC and TRU waste containers stored in Building 991 are impacted by the DBE event due to falling debris (e g , overhead cranes, HVAC ducts, etc) that can fall onto exposed containers and lead to a breach of a fraction of the containers

As a conservatism in the analysis, the Building 991 Complex inventory is assumed to be composed of only TRU waste drums rather than a mixture of POC containers and TRU waste containers This is conservative because POC containers are more resistant to breaches than TRU waste containers (comparison of Feature F3 with Feature F5, statement of Feature F7, comparison of Feature F10 with Feature F12, comparison of Feature F13 and Feature F14) and analysis of the POCs indicates that they are not susceptible to breach from falling material unless they are impacted on the side Since no waste containers are expected to topple, the impact on exposed containers will be on the top of the container Therefore, the analysis of the DBE event induced spill release will be performed using TRU waste drums only

It is assumed that 10% of the exposed drums (drum lids exposed to the ceiling) in the facility will be subject to debris from the partial collapse of Building 991 The 10% value is based on engineering judgment and is believed to be conservative since the facility is not collapsing and the limited amount of overhead materials available in the facility to fall onto drums There are overhead cranes in Room 134 and Room 170 that could potentially impact waste containers and the HVAC ductwork only covers a small portion of the total ceiling area Of the drums subjected to falling debris, it is assumed that 10% of the drums are breached to the point of losing confinement of radioactive material contents (*i e* , penetration of drum and internal packaging) The 10% value is also based on engineering judgment and takes into account the strength of the drums (*i e* , ***metal waste drum/container*** controls) and the types of overhead materials that may fall (*i e* , limited amount of heavy, penetrating overhead materials)

A conservative estimate of the number of TRU waste drums that can be stored in Building 991 is 4,032 drums (excludes 760 drums from Building 996 and Building 998) This estimate is based on the following assumed room inventories and stacking arrangements

Room 134	850 drums total	213 exposed drums	212 drums on upper tier
Room 135	24 drums total	24 exposed drums	no drums on upper tiers
Room 140/141	600 drums total	200 exposed drums	200 drums on upper tier
Room 142	80 drums total	40 exposed drums	no drums on upper tiers
Room 143	300 drums total	100 exposed drums	100 drums on upper tier
Room 147	60 drums total	60 exposed drums	no drums on upper tiers
Room 148	20 drums total	20 exposed drums	no drums on upper tiers
Room 151	400 drums total	134 exposed drums	133 drums on upper tier
Room 153	104 drums total	52 exposed drums	no drums on upper tiers
Room 155	120 drums total	120 exposed drums	no drums on upper tiers
Room 158	56 drums total	56 exposed drums	no drums on upper tiers
Room 166	650 drums total	163 exposed drums	162 drums on upper tier
Room 170	768 drums total	192 exposed drums	192 drums on upper tier

The above room loading assumptions are not intended to be restrictions on room inventories or stacking arrangements but are used only as estimates of the building inventory for the purposes of determining approximate DBE consequences Conservative assumptions dealing with damage factors, inventories, and container contents that go into the MAR estimate for the DBE accident scenario are expected to cover all variations of the drum totals and stacking arrangements except for significant departures (more than 25% increases) from the above assumptions

The total number of exposed drums in Building 991, based on the above assumptions, is 1,374 drums Taking 10% as being subjected to debris and the 10% of those subjected to debris that are penetrated yields approximately 14 drums that are breached by falling debris The resulting damage ratio (approximately 14 drums out of 4,032 drums are breached) is approximately 0 35% As added conservatism, the analysis assumes that the overall equivalent damage ratio is 0 5% which yields 20 drums being breached by the DBE event

A ***container radioactive material loading*** limit is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent) Under an assumption that the inventory is composed entirely of TRU waste drums, the total inventory for the Building 991 (excluding Building 996 and Building 998) is estimated to be 806 4 kilograms of WG Pu (or equivalent) This is not a restriction on the Building 991 inventory Using the conservative overall equivalent damage ratio of 0 5%, the total effective MAR for the DBE resulting in the breach of the waste container(s) is approximately 4,000 grams of WG Pu (or equivalent) A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y

Scenario Modeling Assumptions 806 4 kilograms, blended DCF, DR ≈ 0 005 [20 drums, 4,000 grams aged WG Pu]

Accident Consequences

The radiological dose consequences of DBE induced spills involving TRU waste containers were originally assessed to be *high* for both the MOI and CW since the evaluated MAR was greater than 157 grams (WG Pu equivalent) This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequences) Based on Table 2, the radiological dose consequences of unmitigated spills (no criticalities, fires, or explosions) were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequences)

The radiological dose consequences of the DBE are *moderate* (0 35 rem) to the MOI and *high* (48 rem) to the CW As stated above, the DBE scenario is analyzed as a confined material release, non-lofted plume, 10 minute duration accident scenario The resulting risk class for the scenario is Risk Class II for the MOI (*unlikely* frequency, *moderate* consequence) and is Risk Class I for the CW (*unlikely* frequency, *high* consequence)

For the IW in the facility at the time of the earthquake, falling debris during the event could hypothetically cause a fatality (*high* consequences) However, inhalation of significant quantities of radioactive materials will not lead to a prompt fatality and radiological *high* consequences No controls are credited for protecting the IW in this scenario since the impacts of the initiating event are so severe that radiological impacts are of comparatively little consequence The ***Emergency Plan*** control would be credited for the development of a facility emergency plan directing the IW to evacuate following spills of radioactive materials. However, the resulting risk class for the DBE scenario is Risk Class II for the IW (*unlikely* frequency, *moderate* consequence) The maintenance of the *moderate* consequence, counter to the Table 2 mitigated spill *low* consequence, is due to the increased radiological exposure in the case where an IW is trapped by the falling debris in which case spill mitigation efforts would be ineffective

Control Set Adequacy/Vulnerability

The postulated DBE has an *unlikely* scenario frequency bin assignment Concurrent failures of mitigative features would lead to an *extremely unlikely* frequency bin assignment for the scenario This automatically reduces the risk class for the CW to Risk Class II regardless of increased consequences from the failure of a mitigative feature The MOI risk class for this sequence is reduced to Risk Class III as long as dose consequences do not increase by more than a factor of 14, otherwise, the risk class will remain at Risk Class II Failures of mitigative features concurrent with the earthquake are not investigated for the IW Slight increases in MAR due to protective feature failures would have no impact on the direct earthquake consequences and would contribute little in increasing any radiological consequences associated with the event due to the amount of material released

Failure of the ***combustible material control*** program could result in a fire concurrent with the DBE If the fire were of significant size, the release fraction assumed in the analysis would significantly increase (*i e*, breached drums could have a combined airborne release fraction and respirable fraction of up to 0 05 rather than the 0 0001 used in the analysis, drums that were not breached could have their inventory added to the effective MAR with a release fraction of 0 0005) Failure of this protective feature could yield significant consequences However, the likelihood of failing the ***combustible material control*** program, having a DBE, and having an ignition source in the area of the excess combustible materials may be a *beyond extremely unlikely* event

Double batching of the TRU waste drum fissile material inventory (failure of the ***container radioactive material loading*** limit) would only increase the MOI dose to approximately 0 7 rem (*moderate* consequence), still lower than that needed for a change to *high* consequences However, the likelihood of a double batching of the approximately 20 random drums involved in the postulated accident would result in a *beyond extremely unlikely* frequency assignment for the scenario

Failure of the ***metal waste container*** protective features could lead to more drums being breached The number of drums breached would have to increase by a factor of 14 (from 20 drums to about 280 drums) to result in a change in the MOI dose consequences from *moderate* to *high* Such a gross failure of the Administrative Control programs associated with this credited feature would be associated with a *beyond extremely unlikely* event

In all situations discussed above, the following defense-in-depth features tend to mitigate the scenario but are not credited in the analysis

- ***Building Structure*** The ***building structure*** design feature can lead to mitigating the effects of the DBE (remaining intact yielding an ambient leakpath factor)

- ***Combustible material control, metal waste containers/drums,*** and ***container radioactive material loading*** The ***combustible material control*** program, the ***metal waste containers/drums*** feature, and the ***container radioactive material loading*** limit all reduce the radiological source term that the IW could be exposed to following the DBE

- ***Emergency Plan*** The ***emergency plan*** directs the IW to evacuate the facility in the event of spills of radioactive material that lessens the worker exposure to radiological material releases

In summary, credible failures of individual mitigative features concurrent with the accident do not increase the risk class of the scenario for the MOI, the IW, or the CW _IW earthquake-induced, fatalities are possible due to occupation of the building during the event and are not impacted by the TRU waste storage mission of the facility

5.9.3 NPH/EE Scenario 2 - BDBE Event-Induced Spill

This accident scenario is discussed below and is summarized in Table 107 located at the end of Section 5 9, *Natural Phenomena and External Event Scenario Accident Analyses* Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text

Accident Scenario

A Beyond Design Basis Event (BDBE) is postulated to occur impacting the POC and TRU waste storage areas in the Building 991 Complex POC and TRU waste containers stored in Building 991 are considered to be susceptible to earthquake impacts Containers that are impacted may be breached by falling debris from the partial collapse of the facility or, in the case of TRU waste containers only, may be subject to falling from upper tiers (third or fourth tiers) of drum stacks The breached containers from falling debris do not spill the container contents from the breach since the breach is at the top or upper portion of the container Since the breaches do not result in radioactive material "flowing" from the breach, as is the case in the forklift tine puncture of containers (see Section 5 5, *Puncture Scenario Accident Analyses*), these container breaches are analyzed as a confined material releases as are the TRU waste container breaches due to falling A ground-level (non-lofted) release of the radioactive material is assumed The spill is a short duration event and a minimum duration release (10 minutes) is analyzed

POC and TRU waste containers stored in tunnels and vaults (*i e*, Building 996 and Building 998) are assumed to survive the BDBE (*i e*, no ceiling collapse due to wall thickness and no falling debris due to minimal overhead material) A concurrent fire, caused by the earthquake, is not considered due to the low combustible loading in the waste storage areas

Scenario Modeling Assumptions spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations (1) the occurrence frequency of a Design Basis Earthquake (DBE) is 8 11 x 10^{-4} per year and is considered to be an *unlikely* event, and (2) the occurrence frequency of a BDBE is estimated to be 3 0 x 10^{-4} per year and is still in the *unlikely* frequency bin As stated above, a concurrent fire with the BDBE is considered *beyond extremely unlikely* due to the credited ***combustible material control*** program that limits the amount of combustibles in waste storage areas Fires in non waste-storage areas may occur but building partial collapse and breach would be expected to vent hot gases from the fires away from waste storage areas

Scenario Modeling Assumptions *unlikely* event [beyond design basis event]

Material-At-Risk

The POC and TRU waste containers stored in Building 991 are impacted by the seismic event in two ways (1) partial collapse of the facility creates significant debris that can fall onto exposed containers and lead to a breach of a fraction of the containers, and (2) third or fourth tier TRU waste drums may topple from the upper tier (drop more than four feet) and result in a breach of a fraction of the drums

As a conservatism in the analysis, the Building 991 Complex inventory is assumed to be composed of only TRU waste drums rather than a mixture of POCs and TRU waste containers This is conservative because (1) both containers would have the same ARF value (*i e*, confined material spill, ARF = 0 001) applied in the scenario, (2) POCs are not susceptible to falls per Feature F2 (eliminates MAR associated with toppled containers from upper tiers of stacks), (3) POCs have a maximum MAR that is **6.3 times** greater than TRU waste drums (comparison of General Assumption G4 and General Assumption G6), (4) POCs have a RF value that is **10 times** lower than TRU waste RF values (*i e*, POC **RF = 0.01**, TRU waste container RF = 0 1), and (5) POCs are more resistant to breaches than TRU waste containers (comparison of Feature F3 with Feature F5, statement of Feature F7, comparison of Feature F10 with Feature F12, comparison of Feature F13 and Feature F14) The last point generally results in a DR of 10% for POCs relative to TRU waste containers Combining all of the above considerations except the stack toppling issue, the POC has a **lower source term** for the seismic event release than does the TRU waste container (*i e*, POC source term is about 6 3% of the TRU waste container source term) Therefore, the analysis of the seismic event induced spill release will be performed using TRU waste drums only

It is assumed that 50% of the exposed drums (drum lids exposed to the ceiling) in the facility will be subject to debris from the partial collapse of Building 991 The 50% value is based on engineering judgment and is believed to be conservative since the entire facility is not collapsing and overhead materials that may fall onto drums do not cover every part of the facility ceiling area Of the drums subjected to falling debris, it is assumed that 10% of the drums are breached to the point of losing confinement of radioactive material contents (*i e*, penetration of drum and internal packaging) The 10% value is also based on engineering judgment and takes into account the strength of the drums (*i e*, ***metal waste drum/container*** controls) and the types of overhead materials that may fall (*i e*, limited amount of heavy, penetrating overhead materials)

It is assumed that third and fourth tier drums may topple during the BDBE It is conservatively assumed that 25% of the drums on the third or fourth tiers of stacks are subject to falling from the top of the stack The 25% value is based on engineering judgment and is believed to be conservative since (1) stacked drums are not susceptible to falling except for very large seismic events (see Section 5 9 1 1 1, *Seismic Events*, discussion), and (2) the credited ***banding*** of drums control reduces the likelihood of drums falling from upper tiers of stacks Of the drums subjected to falling from upper tiers, it is assumed that 25% of the drums are breached to the point of losing confinement of radioactive material contents (*i e*, failure of drum and internal packaging) The 25% value is also based on engineering judgment and takes into account the strength of the drums (*i e* , ***metal waste drum/container*** controls), the ***banding*** of drums control (a single drum in the four banded set is subject to damage from the crushing weight of the other three drums in the banded set), and the limited amount of room available for upper tier drums to fall onto the floor (*i e* , other drums in the way or limited aisle space) Additional strength or resistance to internal package breaching as a result of falling is provided by rigid liners and at least one polyurethane bag Drums that are compliant with internal packaging requirements have these barriers Non-compliant drums do not have both of the barriers and are more susceptible to internal package breach as a result of drum falling It is assumed that 20% of the compliant breached drums, as a result of falling, will have breaches of the internal packaging It is conservatively assumed that 100% of the non-compliant breached drums will have internal package failure No control has been specified to restrict internal packaging non-compliant TRU waste drums from the Building 991 Complex so the Site statistics for non-compliant drums are used in the analysis It is conservatively assumed that 85% of drums on the Site are compliant with internal packaging requirements (based on Real Time Radiography, RTR, statistics that over 86% were compliant (Ref 64)) leaving 15% that are not compliant

A conservative estimate of the number of TRU waste drums that can be stored in Building 991 is 4,032 drums (excludes 760 drums from Building 996 and Building 998) This estimate is based on the following assumed room inventories and stacking arrangements

Room 134	850 drums total	213 exposed drums	212 drums on upper tier
Room 135	24 drums total	24 exposed drums	no drums on upper tiers
Room 140/141	600 drums total	200 exposed drums	200 drums on upper tier
Room 142	80 drums total	40 exposed drums	no drums on upper tiers
Room 143	300 drums total	100 exposed drums	100 drums on upper tier
Room 147	60 drums total	60 exposed drums	no drums on upper tiers
Room 148	20 drums total	20 exposed drums	no drums on upper tiers
Room 151	400 drums total	134 exposed drums	133 drums on upper tier
Room 153	104 drums total	52 exposed drums	no drums on upper tiers
Room 155	120 drums total	120 exposed drums	no drums on upper tiers
Room 158	56 drums total	56 exposed drums	no drums on upper tiers
Room 166	650 drums total	163 exposed drums	162 drums on upper tier
Room 170	768 drums total	192 exposed drums	192 drums on upper tier

The above room loading assumptions are not intended to be restrictions on room inventories or stacking arrangements but are used only as estimates of the building inventory for the purposes of determining approximate BDBE consequences Conservative assumptions dealing with damage factors, inventories, and container contents that go into the MAR estimate for the BDBE accident scenario are expected to cover all variations of the drum totals and stacking arrangements except for significant departures (more than 25% increases) from the above assumptions

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The total number of exposed drums in Building 991, based on the above assumptions, is 1,374 drums Taking 50% as being subjected to debris and the 10% of those subjected to debris that are penetrated yields approximately 69 drums that are breached by falling debris The total number of upper tier drums (top layer of third or fourth tier drums, does not count third tier drums that are under fourth tier drums) is 999 drums Taking 25% of the upper tier drums as falling and 25% of the falling drums having the drum fail yields approximately 62 drums that fail due to falling from upper tiers Of the falling drums, 85% are assumed to have compliant internal packaging of which 20% are assumed to experience internal package breach as a result of the fall The remain 15% non-compliant drums are assumed to experience internal package breach as well yielding approximately 20 drums that are completely breached due to falling The resulting overall equivalent damage ratio (approximately 89 drums out of 4,032 drums are breached) is approximately 2 2% As added conservatism, the analysis assumes that the overall equivalent damage ratio is 2 5%

A ***container radioactive material loading*** limit is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent) Under an assumption that the inventory is composed entirely of TRU waste drums, the total inventory for the Building 991 (excluding Building 996 and Building 998) is estimated to be 806 4 kilograms of WG Pu (or equivalent) This is not a restriction on the Building 991 inventory Using the conservative overall equivalent damage ratio of 2 5%, the total effective MAR for the BDBE resulting in the breach of the waste container(s) is 20 16 kilograms of WG Pu (or equivalent) A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y

Scenario Modeling Assumptions 806 4 kilograms, blended DCF, DR = 0 025

Accident Consequences

The radiological dose consequences of BDBE induced spills involving TRU waste containers were originally assessed to be *high* for both the MOI and CW since the evaluated MAR was greater than 157 grams (WG Pu equivalent) This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequences) Based on Table 2, the radiological dose consequences of unmitigated spills (no criticalities, fires, or explosions) were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequences)

The radiological dose consequences of the BDBE are *moderate* (1 7 rem) to the MOI and *high* (240 rem) to the CW As stated above, the BDBE scenario is analyzed as a confined material release, non-lofted plume, 10 minute duration accident scenario Since this event is considered to be a beyond design basis event, the accident scenario risk classes for the MOI and CW are not applicable

For the IW in the facility at the time of the earthquake, partial facility collapse could hypothetically cause a fatality (*high* consequences) However, inhalation of significant quantities of radioactive materials will not lead to a prompt fatality and radiological *high* consequences

No controls are credited for protecting the IW in this scenario since the impacts of the initiating event are so severe that radiological impacts are of little consequence. For lesser seismic events, the same controls that protect the MOI and the CW provide protection for the IW. In addition, the ***Emergency Plan*** control would be credited for the development of a facility emergency plan directing the IW to evacuate following spills of radioactive materials. Since this event is considered to be a beyond design basis event, the accident scenario risk class for the IW is not applicable.

Control Set Adequacy/Vulnerability

Control set adequacy and vulnerability are not applicable since this event is considered to be a beyond design basis event.

The following defense-in-depth features tend to mitigate the scenario but are not credited in the analysis

- ***Building Structure*** The ***building structure*** design feature can lead to the preventing (reducing the likelihood of building partial collapse) and mitigating the effects of the BDBE (remaining intact yielding an ambient leakpath factor and reducing the number of drums impacted by falling debris, allowing the IW to survive the event and evacuate the facility)

- ***Combustible material control***, ***metal waste containers/drums***, ***container radioactive material loading***, and ***banding*** of drums. The ***combustible material control*** program, the ***metal waste containers/drums*** feature, the ***container radioactive material loading*** limit, and the ***banding*** of drums all reduce the radiological source term that the IW could be exposed to following the BDBE

- ***Emergency Plan*** The ***emergency plan*** directs the IW to evacuate the facility in the event of spills of radioactive material that lessens the worker exposure to radiological material releases

As discussed above, the defense-in-depth controls for protecting the IW are of limited value if the earthquake is large enough to collapse the facility. These controls have more importance for lesser seismic events

5.9.4 NPH/EE Scenario 3 – Heavy Snow Event-Induced Spill

This accident scenario is discussed below and is summarized in Table 108 located at the end of Section 5.9, *Natural Phenomena and External Event Scenario Accident Analyses*. Protective features identified in the discussions that follow will be indicated in ***bold italicized*** text.

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Accident Scenario

A heavy snow event is postulated to occur impacting the POC and TRU waste storage areas in the Building 991 Complex. POC and TRU waste containers stored in Building 991 are considered to be susceptible to heavy snow-induced facility collapse impacts. Containers that are impacted may be breached by falling debris from the partial collapse of the facility. The breached containers from falling debris do not spill the container contents from the breach since the breach is at the top or upper portion of the container. Since the breaches do not result in radioactive material "flowing" from the breach, as is the case in the forklift tine puncture of containers (see Section 5.5, *Puncture Scenario Accident Analyses*), these container breaches are analyzed as a confined material releases. A ground-level (non-lofted) release of the radioactive material is assumed. The spill is a short duration event and a minimum duration release (10 minutes) is analyzed. No credit is taken for the retention of released radioactive material by the snow that may be covering some of the breached containers.

POC and TRU waste containers stored in tunnels and vaults (*i.e.*, Building 996 and Building 998) are assumed to survive the heavy snow-induced facility collapse (*i.e.*, no ceiling collapse due to wall thickness).

Scenario Modeling Assumptions: spill, confined material, 10 minute duration, non-lofted plume

Accident Frequency

The likelihood of this postulated accident scenario is judged to be *unlikely* based on the structural capacity of the roofs over waste container storage areas and the likelihood of heavy snows exceeding the structural capacity. The frequency of exceedance for a heavy snow exceeding the facility structural capacity and design basis was found to be less than 10^{-3}/yr.

Scenario Modeling Assumptions: *unlikely* event [beyond design basis event]

Material-At-Risk

The POC and TRU waste containers stored in Building 991 are impacted by the heavy snow event due to the partial collapse of the facility creating significant debris that can fall onto exposed containers and lead to a breach of a fraction of the containers.

As a conservatism in the analysis, the Building 991 Complex inventory is assumed to be composed of only TRU waste drums rather than a mixture of POCs and TRU waste containers. This is conservative because: (1) both containers would have the same ARF value (*i.e.*, confined material spill, ARF = 0.001) applied in the scenario, (2) POCs have a maximum MAR that is **6.3 times** greater than TRU waste drums (comparison of General Assumption G4 and General Assumption G6), (3) POCs have a RF value that is **10 times** lower than TRU waste RF values (*i.e.*, POC **RF = 0.01**, TRU waste container RF = 0.1), and (4) POCs are more resistant to breaches than TRU waste containers (comparison of Feature F3 with Feature F5, statement of Feature F7, comparison of Feature F10 with Feature F12, comparison of Feature F13 and

Feature F14) The last point generally results in a DR of 10% for POCs relative to TRU waste containers Combining all of the above considerations, the POC has a **lower source term** for the heavy snow event release than does the TRU waste container (*i e*, POC source term is about 6 3% of the TRU waste container source term) Therefore, the analysis of the heavy snow event induced spill release will be performed using TRU waste drums only

It is assumed that 50% of the exposed drums (drum lids exposed to the ceiling) in a particular area of the facility will be subject to debris from the partial collapse of Building 991 The 50% value is based on engineering judgment and is believed to be conservative since the entire facility is not collapsing and overhead materials that may fall onto drums do not cover every part of the facility ceiling area It is assumed that only a single area or room of the facility will be exposed to the roof collapse due to the higher vulnerability of specific roof areas and the low likelihood of a spontaneous collapse of the entire facility Room 134 has one of the weakest roof sections Most other areas either have stronger roofs, sloped roofs (less susceptible to heavy snow induced collapse than flat roofs), or are partially/fully underground Room 166, which may also be vulnerable to the heavy snow event, has fewer exposed containers than Room 134 (see discussion below) Of the drums subjected to falling debris, it is assumed that 10% of the drums are breached to the point of losing confinement of radioactive material contents (*i e*, penetration of drum and internal packaging) The 10% value is also based on engineering judgment and takes into account the strength of the drums (*i e*, ***metal waste drum/container*** controls) and the types of overhead materials that may fall along with the collapsing roof section (*i e*, limited amount of heavy, penetrating overhead materials)

A conservative estimate of the number of TRU waste drums that can be stored in Building 991 is 4,032 drums (excludes 760 drums from Building 996 and Building 998) This estimate is based on the following assumed room inventories and stacking arrangements

Room 134	850 drums total	213 exposed drums	212 drums on upper tier
Room 135	24 drums total	24 exposed drums	no drums on upper tiers
Room 140/141	600 drums total	200 exposed drums	200 drums on upper tier
Room 142	80 drums total	40 exposed drums	no drums on upper tiers
Room 143	300 drums total	100 exposed drums	100 drums on upper tier
Room 147	60 drums total	60 exposed drums	no drums on upper tiers
Room 148	20 drums total	20 exposed drums	no drums on upper tiers
Room 151	400 drums total	134 exposed drums	133 drums on upper tier
Room 153	104 drums total	52 exposed drums	no drums on upper tiers
Room 155	120 drums total	120 exposed drums	no drums on upper tiers
Room 158	56 drums total	56 exposed drums	no drums on upper tiers
Room 166	650 drums total	163 exposed drums	162 drums on upper tier
Room 170	768 drums total	192 exposed drums	192 drums on upper tier

The above room loading assumptions are not intended to be restrictions on room inventories or stacking arrangements but are used only as estimates of the building inventory for the purposes of determining approximate BDBE consequences Conservative assumptions dealing with damage factors, inventories, and container contents that go into the MAR estimate for the heavy snow accident scenario are expected to cover all variations of the drum totals and stacking arrangements except for significant departures (more than 25% increases) from the above assumptions

The total number of exposed drums in Building 991, based on the above assumptions, is 1,374 drums Under the assumption that only a single area is impacted by the heavy snow event and conservatively assuming that the area with most exposed drums is impacted, the total number of exposed drums of interest is 213 drums (Room 134 loading arrangement) Taking 50% as being subjected to debris and the 10% of those subjected to debris that are penetrated yields approximately 11 drums that are breached by falling debris Given an inventory in Room 134 of 850 drums, the damage ratio for the heavy snow-induced facility collapse is 1 25% As added conservatism, the analysis assumes that the overall equivalent damage ratio is 1 5%

A ***container radioactive material loading*** limit is credited for limiting TRU waste drum contents to a maximum of 200 grams of WG Pu (or equivalent) Under an assumption that the inventory in Room 134 is composed entirely of TRU waste drums, the total inventory for Room 134 is estimated to be 170 kilograms of WG Pu (or equivalent) This is not a restriction on the Room 134 inventory Using a conservative overall equivalent damage ratio of 1 5%, the total effective MAR for the heavy snow event resulting in the breach of the waste container(s) is 2 55 kilograms of WG Pu (or equivalent) A blended DCF of 3 3E+07 is used to conservatively account for the population mix of waste container IDCs, some of which should be modeled with Solubility Class W and some of which should be modeled with Solubility Class Y

Scenario Modeling Assumptions 170 kilograms, blended DCF, DR = 0 015

Accident Consequences

The radiological dose consequences of heavy snow induced spills involving TRU waste containers were originally assessed to be *high* for both the MOI and CW since the evaluated MAR was greater than 157 grams (WG Pu equivalent) This yielded an initial risk class for the scenario of Risk Class I for both receptors (*unlikely* frequency, *high* consequences) Based on Table 2, the radiological dose consequences of unmitigated spills (no criticalities, fires, or explosions) were originally assessed to be *moderate* for the IW This yielded an initial risk class for the scenario of Risk Class II for the IW (*unlikely* frequency, *moderate* consequences)

The radiological dose consequences of the heavy snow event are *moderate* (0 22 rem) to the MOI and *high* (30 rem) to the CW As stated above, the heavy snow scenario is analyzed as a confined material release, non-lofted plume, 10 minute duration accident scenario Since this event is considered to be a beyond design basis event, the accident scenario risk classes for the MOI and CW are not applicable

For the IW in the facility at the time of the heavy snow event, partial facility collapse could hypothetically cause a fatality (*high* consequences) However, inhalation of significant quantities of radioactive materials will not lead to a prompt fatality and radiological *high*

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consequences No controls are credited for protecting the IW in the facility at the time of the accident since the impacts of the initiating event are so severe that radiological impacts are of little consequence The ***Emergency Plan*** control is credited for the development of a facility emergency plan directing the IW to evacuate the facility if roof snow loading is approaching roof capacity and following spills of radioactive materials The radiological dose consequences for the IW are qualitatively judged to be *low*, consistent with Table 2 for mitigated spills, due to (1) the moderate amount of radiological material that is released, (2) the observable conditions and warning prior to roof failure allowing for facility evacuation, (3) the indicators of the event for non-evacuated IW (*e g*, hole in roof, cold air in facility, noise), and (4) the building ***emergency plan*** that directs the IW to evacuate Since this event is considered to be a beyond design basis event, the accident scenario risk class for the IW is not applicable

Control Set Adequacy/Vulnerability

Control set adequacy and vulnerability are not applicable since this event is considered to be a beyond design basis event

The following defense-in-depth features tend to mitigate the scenario but are not credited in the analysis

- ***Building Structure*** The ***building structure*** design feature can lead to the preventing (reducing the likelihood of building partial collapse) and mitigating the effects of the heavy snow event (remaining intact yielding an ambient leakpath factor and reducing the number of drums impacted by falling debris, allowing the IW to survive the event and evacuate the facility)

- ***Metal waste containers/drums*** and ***container radioactive material loading*** The ***metal waste containers/drums*** feature and the ***container radioactive material loading*** limit all reduce the radiological source term that the IW could be exposed to following the heavy snow-induced facility collapse

- ***Emergency Plan*** The ***emergency plan*** directs the IW to evacuate the facility in the event of spills of radioactive material that lessens the worker exposure to radiological material releases

5.9.5 NPH/EE Scenario Assumptions, Features, Requirements

In the evaluation of the NPH/EE scenarios, assumptions, protective features, and requirements were identified for prevention of the accidents This information is found in Section 4 3 6 8, *Natural Phenomena and External Event Scenarios Determination*, and in Section 5 9, *Natural Phenomena and External Event Scenario Accident Analyses* Table 105 presents a listing of the general assumptions (coded by the letter "G") made, assumptions (coded by the letter "A") made, the protective features (coded by the letter "F") credited, and requirements (coded by the letter "R") specified in the evaluation of NPH/EE scenarios The scenarios to which each assumption, feature, or requirements applies are listed in the table along with the impact of the assumption, feature, or requirement

Table 105 Assumptions/Features/Requirements for NPH/EE Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	NPH/EE Scenario 1 NPH/EE Scenario 2 NPH/EE Scenario 3	Sets the potential MAR for many scenarios impacting waste containers (200 grams for facility fires and container explosions, 320 grams for facility fires, spills, punctures, container explosions, and criticality potential) ***Container Radioactive Material Loading***
A2	Damaging high winds and heavy snows are *anticipated* events except over vaults, damaging lightning strikes are *anticipated* events, freezing events impacting the complex are *anticipated*, damaging heavy rains and flooding are *unlikely* events, facility collapse due to seismic events is *unlikely* except for below ground vaults, damaging tornadoes are *unlikely* events, damaging range fires are *extremely unlikely* events	NPH/EE General Application	Sets the likelihood of natural phenomena events
A3	Damaging tunnel failure and floor loading failures are *unlikely* events, damaging aircraft crashes are *extremely unlikely* events	SPILL-3-SNM, WASTE [aircraft crash] PUNCT-3-SNM, WASTE [aircraft crash] CRIT-4-SNM, WASTE [aircraft crash]	Sets the likelihood of some internal and external events
A15	Natural gas or propane explosions are not expected to occur following an aircraft crash event due to the fire associated with the event preventing the buildup of gases to explosive levels	FEXPLO-1 [aircraft crash] FEXPLO-2 [aircraft crash] CRIT-5 [aircraft crash]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following an aircraft crash to *Beyond Extremely Unlikely*

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Table 105 Assumptions/Features/Requirements for NPH/EE Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A16	Natural gas or propane explosions are not expected to occur following high wind or tornado events due to the wind dispersal of the flammable gases preventing the buildup of gases to explosive levels	FEXPLO-1 [high wind] FEXPLO-1 [tornado] FEXPLO-2 [high wind] FEXPLO-2 [tornado] CRIT-5 [high wind] CRIT-5 [tornado]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following high wind or tornado events to *Beyond Extremely Unlikely*
A17	Forces associated with waste storage area flooding following heavy rain, flooding, or freezing induced flooding events are not expected to be sufficient to result in waste container stack toppling	SPILL-4 [heavy rain] SPILL-4 [flooding] SPILL-4 [freezing] SPILL-8 [heavy rain] SPILL-8 [flooding] SPILL-8 [freezing]	Reduces the likelihood of radioactive material container failure from scenarios dealing with flooding following heavy rain, flooding, or freezing induced flooding events to *Beyond Extremely Unlikely*
A19	A drop/fall of banded TRU or low-level waste containers results in the equivalent release of material of one waste container	NPH/EE Scenario 2	Sets the potential MAR for the scenario impacting TRU or low-level waste containers ***Banding***
F6	Type B shipping containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	SPILL-3-SNM [aircraft crash] PUNCT-3-SNM [aircraft crash] CRIT-4-SNM [aircraft crash]	Reduces the likelihood of Type B shipping container failure for scenarios dealing with structural members impacting containers by one frequency bin ***Type B Shipping Container***
F7	POC containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	SPILL-3-WASTE [aircraft crash] PUNCT-3-WASTE [aircraft crash] CRIT-4-WASTE [aircraft crash]	Reduces the likelihood of POC container failure for scenarios dealing with structural members impacting containers by one frequency bin ***POC Container***
F28	TRU and low-level waste containers cannot be breached by falls less than four feet	NPH/EE Scenario 1 NPH/EE Scenario 2 NPH/EE Scenario 3	Reduces the likelihood of TRU and low-level waste container failure due to dropping from less than four feet to *Beyond Extremely Unlikely* ***Metal Waste Container***

Table 105 Assumptions/Features/Requirements for NPH/EE Scenarios

#	ASSUMPTION/CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R8	A combustible material and ignition source control program shall be implemented to make fires in areas containing staged, stored, or in-process (*i e*, GEN activity) radioactive material *unlikely* events	NPH/EE Scenario 1 NPH/EE Scenario 2	
R8a	Elements of combustible material control include • high heat release rate combustible material restrictions, • no wooden crates in internal waste storage areas, • combustibles have five foot separation from waste containers		Reduces the likelihood of facility fires potentially impacting radioactive material to *Unlikely* ***Combustible Material Control*** ***Ignition Source Control***
R8b	Elements of ignition source control include • restrictions on smoking in facilities, • hot work permits		
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	NPH/EE Scenario 3	Reduces the exposure of the IW to releases and prevents exposure of the IW to snow load-induced facility collapse ***Emergency Plan***
R20	Waste containers stacked above the second tier will be banded	NPH/EE Scenario 2	Reduces the effective MAR of the scenario due to a pallet of TRU waste container dropping or falling from the third or fourth tier of the stack ***Banding***

Table 106 NPH/EE Scenario 1 - DBE Event-Induced Spill

Hazard	4B (Radioactive Materials/Waste Container) and 13H (Other Hazards/Seismic Induced Spills)
Accident Type	Spill involving 20 TRU waste drums, drum breach due to falling overhead equipment impacting exposed drums, Effective MAR ≈ 4,000 grams of aged WG Pu,
Cause or Energy Source	[causes] 13H (Seismic Induced Spills) [energy sources] falling overhead equipment
Applicable Activity(ies)	WASTE

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation	With Prevention/ Mitigation				
MOI	Unlikely	Unlikely	High	Moderate 0 35 rem	I	II	Metal Waste Container/Drum [F28] Combustible Material Control [R8] Container Rad Material Loading [G4] Building Structure	C C C D	M M M P	AC 5 2 AC 5 3 AC 5 2 Design Feat
CW	Unlikely	Unlikely	High	High 48 rem	I	I	Same as MOI			
IW	Unlikely	Unlikely	Moderate	Moderate	II	II	Metal Waste Container/Drum Combustible Material Control Container Rad Material Loading Building Structure Emergency Plan	D D D D D	M M M P M	AC 5 2 AC 5 3 AC 5 2 Design Feat AC 5 6

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

Table 107 NPH/EE Scenario 2 - BDBE Event-Induced Spill

Hazard	4B (Radioactive Materials/Waste Container) and 13H (Other Hazards/Seismic Induced Spills)
Accident Type	Spill involving 101 TRU waste drums, drum breach due to falling structure impacting exposed drums or toppling from stack for third or fourth tier drums, Effective MAR = 20,160 grams of aged WG Pu,
Cause or Energy Source	[causes] 13H (Seismic Induced Spills) [energy sources] 8C (Stacked Waste Containers) and falling structure
Applicable Activity(ies)	WASTE

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation.	With Prevention/ Mitigation				
MOI	Unlikely	Unlikely	High	Moderate 1 7 rem	I[2]	N/A – beyond design basis	Metal Waste Container/Drum [F28] Combustible Material Control [R8] Container Rad Material Loading [G4] Banding [A19/R20] Building Structure	C C C C D	M M M M P	AC 5 2 AC 5 3 AC 5 2 AC 5 2 Design Feat
CW	Unlikely	Unlikely	High	High 240 rem	I[2]	N/A – beyond design basis	Same as MOI			
IW	Unlikely	Unlikely	Moderate	Moderate	II[2]	N/A – beyond design basis	Metal Waste Container/Drum Combustible Material Control Container Rad Material Loading Banding Building Structure Emergency Plan	D D D D D D	M M M M P M	AC 5 2 AC 5 3 AC 5 2 AC 5 2 Design Feat AC 5 6

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

[2]Scenario Risk Class shown for Without Prevention/Mitigation to present hazard evaluation initial assessment

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Table 108 NPH/EE Scenario 3 – Heavy Snow Event-Induced Spill

Hazard	4B (Radioactive Materials/Waste Container) and 13H (Other Hazards/Heavy Snow Induced Spills)
Accident Type	Spill involving about 13 TRU waste drums, drum breach due to falling structure impacting exposed drums, Effective MAR = 2,550 grams of aged WG Pu,
Cause or Energy Source	[causes] 13H (Heavy Snow Induced Spills) [energy sources] falling structure
Applicable Activity(ies)	WASTE

Receptor	Scenario Frequency		Scenario Consequence		Scenario Risk Class		Protective Feature[1]	Feature Type Credited Defense	Feature Purpose Prevent Mitigate	Reference to TSRs
	Without Prevention[1]	With Prevention	Without Mitigation[1]	With Mitigation	Without Prevention/ Mitigation	With Prevention/ Mitigation				
MOI	Unlikely	Unlikely	High	Moderate 0 22 rem	I[2]	N/A – beyond design basis	Metal Waste Container/Drum [F28] Container Rad Material Loading [G4] Building Structure Emergency Plan	C C D D	M M P P	AC 5 2 AC 5 2 Design Feat AC 5 6
CW	Unlikely	Unlikely	High	High 30 rem	I[2]	N/A – beyond design basis	Same as MOI			
IW	Unlikely	Unlikely	Moderate	Low	II[2]	N/A – beyond design basis	Emergency Plan [R12] Metal Waste Container/Drum Container Rad Material Loading Building Structure Emergency Plan	C D D D D	P M M P M	AC 5 6 AC 5 2 AC 5 2 Design Feat AC 5 6

[1]Underlined Credited Protective Features are included as inherent and credited controls in the Without Prevention/Mitigation Scenario Frequency/Consequence/Risk Class determinations

[2]Scenario Risk Class shown for Without Prevention/Mitigation to present hazard evaluation initial assessment

6. RISK DOMINANT ACCIDENT SCENARIOS

This section discusses the dominant risk contributors to the MOI, CW, and IW These accident scenarios have significant risk even after crediting preventive and mitigative features, and are categorized as Risk Class I or Risk Class II for at least one of the three receptors Of the dominant risk accident scenarios, no scenarios resulted in *high* consequences to the MOI, three scenarios resulted in *high* consequences to the CW, and no scenarios resulted in *high* consequences to the IW

Table 109 summarizes the risk dominant accident scenarios that were identified for the Building 991 Complex The first column of the table lists the risk dominant accident scenario and provides a brief description of the accident The *Analyzed Risk Class* columns identify the risk for each receptor as analyzed in the accident analysis section The frequency bin, consequence bin, dose consequence, and risk class for each receptor (IW does not have a dose consequence), as analyzed, are provided for the accident scenario The *Additional Considerations for Risk Reduction* columns identify the risk for the receptor of concern after additional considerations are taken into account These considerations may deal with a relaxation of the conservative modeling input assumptions utilized in the accident analysis and how using more realistic assumptions could reduce the frequency or consequences of the event (*e g*, use of median χ/Q values, use of more realistic MAR values). The considerations could also deal with additional preventive/mitigative features that were not taken credit for in the accident analysis that could reduce the frequency or consequences of the event The *Risk Reduction Remarks* column provides a brief description of the consideration(s) used to reduce the risk A detailed discussion of the risk reduction consideration is provided for each risk dominant accident scenario

Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire

A facility fire is postulated to impact up to three 55-gallon waste containers The facility fire is postulated to occur as a result of combustibles (modeled as wooden pallets with a total heat load of 1 MW) being ignited during the conduct of hot work or by exposure to electrical system components The facility fire may occur in Building 996, any north waste storage area, or any south waste storage area The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste containers The fire causes heating of the waste containers and their contents, pyrolyzing of the container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals This size fire is postulated to activate the automatic sprinkler system in the north waste storage areas (excluding Building 996) but the sprinkler system does not reduce the number of drums involved in the fire in this area The automatic sprinkler system is not activated in the south waste storage area due to ceiling height

The postulated facility fire involving three 55-gallon TRU waste drums in the Building 991 Complex is considered to be an *unlikely* event with *moderate* consequences for the MOI, *high* consequences for the CW, and *low* consequences for the IW The MOI and CW risk

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classes are Risk Class II and Risk Class I, respectively The risk class for the IW is Risk Class III, which is considered to be acceptable

Portions of the waste storage areas for the Building 991 Complex have filtered exhaust ventilation Specifically, the north waste storage areas and the Building 996 waste storage area are ventilated The south waste storage areas (excluding Room 166), while not directly supported by a filtered exhaust ventilation system, have sufficient negative differential pressure with respect to atmosphere under certain configurations to credit the filtration provided by the north waste storage area ventilation system The fire being evaluated is not expected to challenge the ventilation system's ability to maintain a negative pressure in the north, Building 996, and most of the south waste storage areas The fire may or may not impact the high efficiency particulate air (HEPA) filters due to blinding or blockage from fire related particulate accumulation on the filters, depending on the quantity of smoke generated by the fire The blockage of the filters due to smoke is not considered a rationale for discrediting the mitigative effects of the filtered exhaust ventilation system The north and most south waste storage areas, excluding Building 998, have the potential to exhaust through a single stage of HEPA filtration Building 996 and Building 998 are potentially exhausted through two stages of HEPA filtration (*i e*, Building 996 through two stages in Building 985 and Building 998 through a single, Building 998 dedicated stage and a single stage in the Building 991 filter plenum) Crediting a single tested stage filter efficiency of 0 999 would reduce the risk class for both the MOI and the CW to Risk Class III (MOI *low* consequence of 2 6E-4 rem, CW *low* consequence of 3 5E-2 rem)

In order to credit the filtered exhaust ventilation system for mitigation of the three drum fire, an acceptable facility configuration must be defined The Building 991 exhaust ventilation system can support mitigation of accident scenarios in all interior container storage/staging areas except for Room 166 An operations restriction to permit ***only POCs to be stored in Room 166*** is imposed to reduce concerns dealing with exterior natural gas lines located outside of Room 166 This same control shall be used to negate concerns about a lack of a ventilation system supporting Room 166 for the mitigation of a three drum fire

As stated above, the ***Building 991 filtered exhaust ventilation system*** supports all other areas The north waste storage areas are directly supported by this system Building 996 and Corridor B are normally supported by the Building 985 filtered exhaust ventilation system, but the Building 991 system can cover these areas if the Building 985 system is not being used However, if the Building 985 exhaust ventilation system is used to support personnel access to the tunnel and vault areas, a ***stage of tested HEPA filtration in Building 985*** is required The tested stage is used to mitigate fires in the Building 996 waste container storage areas and to mitigate some fires in the Building 991 container storage/staging areas (*i e*, some areas of Building 991 are ventilated by Building 985 due to competitive suction between the two ventilation systems) for fires occurring while the Building 985 system is operating

The south waste container storage areas other than Room 166, are supported by the ***Building 991 filtered exhaust ventilation system*** under certain facility configurations The waste container storage areas being supported are Room 134 (including connected Room 135)

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and Room 170 (including connected Room 147) The two main rooms must have an airflow connection, in some way, to the north areas of Building 991 in order that a negative differential pressure with respect to atmosphere can be created in areas The following ***facility configurations*** are considered to be acceptable for providing an airflow connection from the south areas to the north areas of Building 991

- For Room 134 (and Room 135)

  1 Airlock doors in the north-south running corridor (connected to the east side of Room 134) are open

  2 Roll-up door between Rooms 134 and 170 is opened **AND** door between Rooms 170 and 140/141 is open

  3 Roll-up door between Rooms 134 and 170 is open **AND** roll-up door between Rooms 170 and 147A (connection to the east-west running corridor in the north area) is open

- For Room 170 (and Room 147) [Note this configuration control is imposed by a ***Room 170 differential pressure*** requirement rather than a door alignment requirement]

  1 Door between Rooms 170 and 140/141 is open

  2 Roll-up door between Rooms 170 and 147A (connection to the east west running corridor in the north area) is open

  3 Roll-up door between Rooms 134 and 170 is open **AND** airlock doors in the north-south running corridor (connected to the east side of Room 134) are open

If the Room 170 dock doors are open, an airflow through the dock doors into Room 170 may exist but no credit is taken for exhaust filtration in Room 170 while the doors are open That is, accident scenarios in Room 147 and 170 occurring when Room 170 dock doors are open are unmitigated In order to ensure that three drum fires in Room 170 are mitigated, a control to restrict operations in Rooms 147 and 170 when the dock doors are open is required However, the dock doors must be open during receiving and shipping operations in Room 170

Receipt and shipment operations in Room 170 are defined as follows

- Movement of waste containers from a transport vehicle at the dock to a staging area in Room 170
- Movement of waste containers from a staging area in Room 170 to a transport vehicle at the dock
- Movement of SNM Type B shipping containers from a transport vehicle at the dock to a vault staging location in the north area of the facility
- Movement of SNM Type B shipping containers from a vault staging location in the north area of the facility to a transport vehicle at the dock

All other container movement within Room 170 or from/to Room 170 are not considered to be part of receipt and shipment operations

Receiving and shipping activities potentially involve the use of electric powered forklifts and may introduce some combustibles into the area (*e g*, wooden pallets, combustible material supplies) However, the entire activity is conducted with personnel present A control to ***restrict all operations, other than receipt and shipment, in Rooms 147 and 170 when dock doors are open*** is imposed to reduce the likelihood of fires and other accident scenarios in the area while the dock doors are open Therefore, it is postulated that the likelihood of a three drum fire occurring during the conduct of receiving or shipping operations is remote for the following reasons

1 Personnel are always in attendance during the conduct of the activities, allowing for mitigation of any small fires occurring in the area before waste containers become involved in the fire

2 Receiving and shipping operations do not involve significant ignition sources (*e g*, only electric powered forklifts versus items like oxyacetylene torches)

3 Combustibles involved in receiving and shipping operations are well controlled and monitored (*e g*, wooden pallets, if any, are collected and placed in areas away from waste containers before removal from the facility)

4 All other operations, including hot work, are suspended while receiving and shipping operations are being conducted

Therefore, if the operations restrictions are imposed, all facility three drum fires can be analyzed crediting a stage of HEPA filtration

When the ***filtered exhaust ventilation system*** is credited for fire scenario mitigation, there is a possibility that the fire may impact the HEPA filters due to high air temperatures or hot embers and flying brands Either of these impacts can result in the ignition of the filter stage, release of radioactive materials that were captured on the filter stage, and subsequent loss of filtration capability However, the three drum fire scenario is not expected to challenge the filters due to elevated temperatures It is also not expected that the three drum fire will have sufficient generation of hot embers and flying brands to challenge the filters due to hot particulates

In summary, crediting the ***Building 991 filtered exhaust ventilation system*** and ***facility configuration*** controls would yield Risk Class III results for the MOI and the CW

Facility Fire Scenario 2 – 2 MW TRU Waste Drum Facility Fire

A facility fire is postulated to impact up to six 55-gallon waste containers The facility fire is postulated to occur as a result of combustibles (modeled as wooden pallets with a heat load of 2 MW) being ignited during the conduct of hot work or by exposure to electrical system components The facility fire may occur in the south waste storage area, north waste storage area, or the Building 996 waste storage area The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste containers The fire causes heating of the waste containers and their contents, pyrolyzing of the container contents, and subsequent venting of container gases containing radioactive material through failed container lid seals This size fire is postulated to activate the automatic sprinkler system in the north waste storage areas (excluding Building 996) Activation of the automatic sprinkler system may or may not occur in the south waste storage areas due to ceiling height, however, the automatic sprinkler system is credited as a preventive/mitigative feature The consequences of this event are reduced if the automatic sprinkler system activates (postulated that the fire will impact three 55-gallon waste containers if the automatic sprinkler system activates)

The postulated facility fire involving six 55-gallon TRU waste drums in the Building 991 Complex is considered to be an *extremely unlikely* event with *moderate* consequences for the MOI, *high* consequences for the CW, and *low* consequences for the IW The CW risk class is Risk Class II The risk classes for the MOI and IW are Risk Class III and Risk Class IV, respectively, which are considered to be acceptable

The analysis of the south waste storage area fires assumes that a 2 MW fire would not set off the automatic fire suppression systems in the south waste storage areas due to the high ceilings in these locations It is possible that the sprinkler system would actuate and suppress the fire to, at worst, a three drum fire (see Section 5 3 2, *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire*) Larger, six drum fires would become *not credible* events as in the case of the north waste area fires if the automatic sprinkler system is actuated.

Portions of the waste storage areas for the Building 991 Complex have filtered exhaust ventilation Specifically, the north waste storage areas and the Building 996 waste storage area are ventilated The south waste storage areas (excluding Room 166), while not directly supported by a filtered exhaust ventilation system, have sufficient negative differential pressure with respect to atmosphere under certain configurations to credit the filtration provided by the north waste storage area ventilation system The fire being evaluated is not expected to challenge the ventilation system's ability to maintain a negative pressure in the north, Building 996, and most of the south waste storage areas The fire may or may not impact the high efficiency particulate air (HEPA) filters due to blinding or blockage from fire related particulate accumulation on the filters, depending on the quantity of smoke generated by the fire The blockage of the filters due to smoke is not considered a rationale for discrediting the mitigative effects of the filtered exhaust ventilation system The north and most south waste storage areas, excluding Building 998, have the potential to exhaust through a single stage of HEPA filtration Building 996 and Building 998 are potentially exhausted through two stages of HEPA filtration (*i e*, Building 996 through two stages in Building 985 and Building 998 through a single, Building 998 dedicated stage and a single stage in the Building 991 filter plenum) Crediting a single tested stage filter efficiency of 0 999 would reduce the risk class for both the MOI and the CW (MOI *low* consequence of 5 2E-4 rem with corresponding Risk Class IV, CW *low* consequence of 0 071 rem with corresponding Risk Class IV)

In order to credit the filtered exhaust ventilation system for mitigation of the six drum fire, an acceptable facility configuration must be defined The discussion under the risk

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dominant *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire* covers the necessary controls to define an acceptable facility configuration

When the ***filtered exhaust ventilation system*** is credited for fire scenario mitigation, there is a possibility that the fire may impact the HEPA filters due to high air temperatures or hot embers and flying brands Either of these impacts can result in the ignition of the filter stage, release of radioactive materials that were captured on the filter stage, and subsequent loss of filtration capability However, the six drum fire scenario is not expected to challenge the filters due to elevated temperatures It is also not expected that the six drum fire will have sufficient generation of hot embers and flying brands to challenge the filters due to hot particulates For fires larger than the six drum fire, the ***automatic plenum deluge systems*** can provide protection for the HEPA filters against high temperatures and, to a lesser extent, against hot embers and flying brands The systems consist of an automatic deluge feature that sprays into the plenum before the demister screen, a manually actuated deluge feature that bypasses the automatic deluge portion of the system and sprays before the demister screen, and a manually actuated deluge feature that sprays directly onto the filter stage This latter feature directly wets the filters and may lead to stage failure due to water damage Actuation of the direct filter spray manual deluge system has the potential to save the filters from burning at the expense of failing the filters due to wetting Due to the low likelihood of the actuation or use of this system (large fires challenging the filters are not considered to be credible) and the potential for filter stage failure following use of the system, the ***automatic plenum deluge systems*** are not credited but serve as a defense-in-depth mitigative feature for protection against very large facility fires

In summary, crediting the ***Building 991 filtered exhaust ventilation system*** and ***facility configuration*** controls would yield Risk Class IV results for the MOI and the CW

Facility Fire Scenario 3 – Medium to Large Wooden LLW Crate Facility Fire

A facility fire is postulated to impact up to four wooden LLW crates The facility fire is postulated to occur as a result of combustibles being ignited during the conduct of hot work, during the receipt or shipment of crates, or by exposure to electrical system components The facility fire occurs in the West Dock Canopy Area The facility fire is assumed to initially involve combustible materials located in close proximity to stored waste crates The wooden crates become involved in the fire and combust along with their contents that are assumed to be combustible The fire is limited to four wooden crates due to fire suppression by the automatic sprinkler system once the fire is sufficiently large to actuate the system

The postulated facility fire involving four wooden LLW crates in the West Dock Canopy Area of the Building 991 Complex is considered to be an *unlikely* event with *low* consequences for the MOI, *moderate* consequences for the CW, and *low* consequences for the IW The CW risk class is Risk Class II The risk class for the MOI and the IW is Risk Class III, which is considered to be acceptable

Acceptability of the risk class results for the CW is based on the conservatism of the analysis (*i e*, modeling input assumptions, defense-in-depth protective features not specifically credited) If a median χ/Q value and non-lofted plume is used in the analysis, the CW consequence is *low* (0 084 rem) If a lofted plume evaluation with 95th percentile χ/Q is performed, the CW consequence is *low* (0 024 rem) Either of these would lower the CW risk class to Risk Class III

The analysis of the West Dock Canopy waste storage area fire assumes that a two or three wooden crate fire would not set off the automatic fire suppression system due to the high ceiling location It is possible that the sprinkler system would actuate earlier and suppress the fire to a lower number of crates A three LLW crate fire is just below the *low* consequence bin threshold value of 0 5 rem If the impact of fire suppression yielded the equivalent of a two or three crate fire, the CW consequence result would be *low* and the corresponding risk class a Risk Class III

Another conservatism deals with the event assumed MAR Most of the wooden LLW crates to be stored in the West Dock Canopy Area come from the drum crushing operation or from the change out of HEPA filters in the complex Both of these sources of LLW have historically had negligible contamination and LLW crates of these materials would be significantly (*i e*, orders of magnitude) less than 3 grams of radioactive material per crate A reduction to approximately the 95th percentile of LLW crate MAR (*i e*, 0 7 grams) would reduce the CW consequences to *low* (0 16 rem) and the risk class to Risk Class III

In summary, removal of analysis conservatism by using **more realistic MAR values** would yield Risk Class III results for the MOI, the CW, and the IW

Spill Scenario 1 – TRU Waste Drums Drop/Fall

A spill is postulated to occur as a result of breaching up to four 55-gallon TRU waste drums containing radioactive material The breach of the drums may occur as a result of the drums being raised on a forklift and falling from that position, or as a result of being stacked on the third or fourth tier and then being impacted by material handling equipment during operations being conducted in the facility Upon impact with the hard surface, the drums are damaged and opened, and the waste packages in the drums are breached by the weight of the waste packages and the force of the impact Due to stacking configurations, this scenario is postulated to occur in those areas where stacking above the second tier may occur These areas include Room 134 (4-high), Room 140/141 (3-high), Room 143 (3-high), Room 151 (3-high), Room 166 (4-high), or Room 170 (4-high)

The postulated spill of a pallet of TRU waste drums in the Building 991 Complex is considered to be an *anticipated* event with *low* consequences to the MOI and IW, and an *anticipated* event with *moderate* consequences to the CW The risk classes for the MOI and IW are Risk Class III, which is considered to be acceptable The risk class for the CW is Risk Class I

Portions of the waste storage areas for the Building 991 Complex have filtered exhaust ventilation Specifically, the north waste storage areas and the Building 996 waste storage area are ventilated The south waste storage areas (excluding Room 166), while not directly supported by a filtered exhaust ventilation system, have sufficient negative differential pressure

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with respect to atmosphere under certain configurations to credit the filtration provided by the north waste storage area ventilation system The north and most south waste storage areas have the potential to exhaust through a single stage of HEPA filtration Building 996 and Building 998 are potentially exhausted through two stages of HEPA filtration (*i e*, Building 996 through two stages in Building 985 and Building 998 through a single, Building 998 dedicated stage and a single stage in the Building 991 filter plenum) but spills are not expected in these areas since there is no stacking above two tiers Crediting a single tested stage filter efficiency of 0 999 would reduce the risk class for the CW by two levels (CW *low* consequence of 3 1E-3 rem with corresponding Risk Class III)

In order to credit the filtered exhaust ventilation system for mitigation of the waste container spill, an acceptable facility configuration must be defined The Building 991 exhaust ventilation system can support mitigation of accident scenarios in all interior container storage/staging areas except for Room 166 An operations restriction to permit ***only POCs to be stored in Room 166*** is imposed to reduce concerns dealing with exterior natural gas lines located outside of Room 166 This same control shall be used to negate concerns about a lack of a ventilation system supporting Room 166 for the mitigation of a waste container spill since POCs are not vulnerable to spills from heights less than 30 feet

As stated above, the ***Building 991 filtered exhaust ventilation system*** supports all other areas The north waste storage areas are directly supported by this system Building 996 and Corridor B are normally supported by the Building 985 filtered exhaust ventilation system, but the Building 991 system can cover these areas if the Building 985 system is not being used However, if the Building 985 exhaust ventilation system is used to support personnel access to the tunnel and vault areas, a ***stage of tested HEPA filtration in Building 985*** is required The tested stage is used to mitigate spills in the Building 996 waste container storage areas and to mitigate some spills in the Building 991 container storage/staging areas (*i e*, some areas of Building 991 are ventilated by Building 985 due to competitive suction between the two ventilation systems) for spills occurring while the Building 985 system is operating

The south waste container storage areas, other than Room 166, are supported by the ***Building 991 filtered exhaust ventilation system*** under certain facility configurations The ***facility configuration*** controls considered to be acceptable for providing an airflow connection from the south areas to the north areas of Building 991 are presented in the discussion under risk dominant *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire*

If the Room 170 dock doors are open, an airflow through the dock doors into Room 170 may exist but no credit is taken for exhaust filtration in Room 170 while the doors are open That is, accident scenarios in Room 147 and 170 occurring when Room 170 dock doors are open are unmitigated In order to ensure that spills in Room 170 are mitigated, a control to restrict operations in Rooms 147 and 170 when the dock doors are open is required However, the dock doors must be open during receiving and shipping operations in Room 170

Receipt and shipment operations in Room 170 are defined as follows

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- Movement of waste containers from a transport vehicle at the dock to a staging area in Room 170
- Movement of waste containers from a staging area in Room 170 to a transport vehicle at the dock
- Movement of SNM Type B shipping containers from a transport vehicle at the dock to a vault staging location in the north area of the facility
- Movement of SNM Type B shipping containers from a vault staging location in the north area of the facility to a transport vehicle at the dock

All other container movement within Room 170 or from/to Room 170 are not considered to be part of receipt and shipment operations

A control to ***restrict all operations, other than receipt and shipment, in Rooms 147 and 170 when dock doors are open*** along with a control to ***restrict waste container stacking above a second tier during receipt and shipment*** are imposed to reduce the likelihood of spill scenarios in the area while the dock doors are open Since all waste containers permitted in the facility are qualified to survive falls of four feet or less (Type B shipping containers and POCs are qualified to 30 feet), restricting stacking above a second tier ensures that containers are not lifted above four feet Therefore, it is postulated that container spill scenarios occurring during the conduct of receiving or shipping operations are precluded If the operations restrictions are imposed, all facility container operations-induced spills can be analyzed crediting a stage of HEPA filtration

Another conservatism deals with the event likelihood Failure of the ***metal waste containers*** resulting in a release of radioactive material could be argued to be an *unlikely* event Even though there have been incidents where containers were dropped or fell in the past, the majority of past events have been of relatively low energy, typically resulting in the denting of containers with no loss of containment If this scenario conservatism were removed, the risk class for the CW would be reduced by one level but the risk classes for the MOI and IW would remain the same

In summary, crediting the ***Building 991 filtered exhaust ventilation system*** and ***facility configuration*** controls would yield Risk Class III results for the CW

Puncture Scenario 1 – LLW, TRU, POC, and Type B Container Punctures (Case B)

A radioactive material spill is postulated to occur as a result of puncturing a TRU waste container The puncture of the container may occur as a result of the container being impacted and punctured by material handling equipment while loading, unloading, and/or transferring the container from its receipt/shipment area to its storage/staging area The puncture may occur in all storage/staging areas in the building as well as the dock areas during receipt/shipment operations The forklift error results in a puncture, by the forklift tines, of two adjacent TRU waste drums located on a pallet A fraction of the contents of the punctured waste containers are postulated to "flow" through the breach onto the ground/floor

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The postulated puncture of two TRU drums (Case B) on a pallet in the Building 991 Complex is considered to be an *unlikely* event with *low* consequences to the MOI and IW, and *moderate* consequences to the CW The risk classes for the MOI and IW are Risk Class III, which is considered to be acceptable The risk class for the CW is Risk Class II

Acceptability of the risk class results for the CW in Case B, in part, is based on the conservatism of the analysis (*i e*, modeling input assumptions, defense-in-depth protective features not specifically credited) In the analysis of Case B it was assumed that a forklift would penetrate two TRU drums on a pallet during the event The scenario also applied a conservative DR of 10% If it is assumed that the forklift would only penetrate one TRU drum during the event, the CW consequence would be reduced by half (3 1 rem) and the scenario risk class would remain Risk Class III

Portions of the waste storage areas for the Building 991 Complex have filtered exhaust ventilation Specifically, the north waste storage areas and the Building 996 waste storage area are ventilated The south waste storage areas (excluding Room 166), while not directly supported by a filtered exhaust ventilation system, have sufficient negative differential pressure with respect to atmosphere under certain configurations to credit the filtration provided by the north waste storage area ventilation system The north and most south waste storage areas have the potential to exhaust through a single stage of HEPA filtration Building 996 and Building 998 are potentially exhausted through two stages of HEPA filtration (*i e*, Building 996 through two stages in Building 985 and Building 998 through a single, Building 998 dedicated stage and a single stage in the Building 991 filter plenum) Crediting a single tested stage filter efficiency of 0 999 would reduce the risk class for the CW for Case B (CW *low* consequence of 6 2E-3 rem with corresponding Risk Class III)

In order to credit the filtered exhaust ventilation system for mitigation of the TRU waste drum puncture, an acceptable facility configuration must be defined The discussion under the risk dominant *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire* covers the necessary controls to define an acceptable facility configuration for most situations However, TRU waste drum puncture events can occur when the Room 170 dock doors are open during receipt and shipment operations (all other operations in Room 147 and 170 require that the dock doors be closed) While significant inflow of air through the dock doors is expected when the doors are open and transport vehicles are parked against the dock, it is conservatively assumed that the radioactive material releases from container puncture events at the dock, with dock doors open, are not mitigated by HEPA filtration

TRU waste drum exposures to forklift tines can occur during any container movement Container movements in areas other than Room 147 and 170 are mitigated by the ***Building 991 filtered exhaust ventilation system*** Container movements in Rooms 147 and 170 while dock doors are closed are also mitigated by the system Container movements during receipt and shipment activities, when the dock doors are open, are assumed to not be mitigated by the ventilation system Therefore, more than half of the container movements will be mitigated

The risk and consequences of Puncture Scenario 1 (Case B) will be presented for two situations 1) Case B1 (unmitigated) represents punctures occurring in Room 147 or 170 while dock doors are open, and 2) Case B2 (mitigated) represents punctures occurring at any other time

In summary, removal of analysis conservatism by assuming only one TRU drum is involved in the puncture event would continue to yield Risk Class II results for the CW for Case B1 (*unlikely* frequency, *moderate* consequences) No credit is taken in Case B1 for the expected inflow of air while dock doors are open that would tend to mitigate the puncture scenario consequences Crediting the ***Building 991 filtered exhaust ventilation system*** and ***facility configuration*** controls would reduce the CW risk to Risk Class III for Case B2 (*unlikely* frequency, *low* consequences)

Container Explosion Scenario 1 – TRU Waste Box Container Explosion

Hydrogen generation in metal waste containers is postulated to lead to an internal hydrogen explosion in a TRU waste container The radioactive decay of the TRU waste material interacts with hydrogenous waste materials and produces hydrogen and oxygen gases The gases are retained in the metal waste container and allowed to accumulate to the point where a hydrogen explosion potential exists Since as little energy as is associated with a static charge can ignite flammable hydrogen/oxygen mixtures, static charges generated by container movements ignite the hydrogen Therefore, the container explosion can occur at any point in the handling of the container (*i e*, at the storage location, at the dock, and during transit) Since the container loses its lid as part of the scenario, the material impacted by the event is no longer confined The scenario deals with an overpressure event that is conservatively assumed to impact radioactive material in the form of a powder

The postulated TRU waste box container explosion in the Building 991 Complex is considered to be an *extremely unlikely* event with *moderate* consequences for the MOI, *high* consequences for the CW, and *moderate* consequences for the IW The CW risk class is Risk Class II The risk classes for the MOI and the IW are Risk Class III, which are considered to be acceptable

Acceptability of the risk class results for the CW, in part, is based on the conservatism of the analysis (*i e*, modeling input assumptions, defense-in-depth protective features not specifically credited) _The rationale that the analysis of a waste box is a conservatism is as follows (1) TRU waste boxes have not been the focus of hydrogen explosion issues at the Site, (2) it is not clear that a TRU waste box has the potential to be involved in an internal hydrogen explosion due to less radioactive material per unit volume, the type of wastes associated with TRU waste boxes, and the significantly larger head space area, and (3) there are far fewer TRU waste boxes than TRU waste drums, which makes the scenario less likely to occur in a TRU waste box

Also, there is conservatism in using the non-combustible contaminated solid release fraction values from the DOE Handbook These values are meant to be applied to rigid, non-yielding contaminated surfaces where the venting gases can act against the rigid surface

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Wastes of this type (*e g*, contaminated metals) are less likely to generate hydrogen by radiolysis than combustible wastes (*e g*, contaminated paper, contaminated plastic) The wastes more likely to generate hydrogen would have a DOE Handbook ARF value of 0 001 and a RF value of 1 0 If these values are used in combination with 95th percentile χ/Q values and a TRU waste drum inventory, the CW consequences remain ***high*** (31 rem) and the risk class remains Risk Class II In this case the MOI consequences become *low* (0 023 rem) and the risk class reduces to Risk Class IV

Portions of the waste storage areas for the Building 991 Complex have filtered exhaust ventilation Specifically, the north waste storage areas and the Building 996 waste storage area are ventilated The south waste storage areas (excluding Room 166), while not directly supported by a filtered exhaust ventilation system, have sufficient negative differential pressure with respect to atmosphere under certain configurations to credit the filtration provided by the north waste storage area ventilation system The north and most south waste storage areas have the potential to exhaust through a single stage of HEPA filtration Building 996 and Building 998 are potentially exhausted through two stages of HEPA filtration (*i e*, Building 996 through two stages in Building 985 and Building 998 through a single, Building 998 dedicated stage and a single stage in the Building 991 filter plenum) Crediting a single tested stage filter efficiency of 0 999 would reduce the risk class for the CW (CW *low* consequence of 0 35 rem with corresponding Risk Class IV, note that the MOI risk class would also be reduced from Risk Class III to Risk Class IV)

In order to credit the filtered exhaust ventilation system for mitigation of the TRU waste container explosion, an acceptable facility configuration must be defined The discussion under the risk dominant *Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire* covers the necessary controls to define an acceptable facility configuration for most situations However, TRU waste container explosion events can occur when the Room 170 dock doors are open during receipt and shipment operations (all other operations in Room 147 and 170 require that the dock doors be closed) While significant inflow of air through the dock doors is expected when the doors are open and transport vehicles are parked against the dock, it is conservatively assumed that the radioactive material releases from container explosion events at the dock, with dock doors open, are not mitigated by HEPA filtration

TRU waste container exposures to static charges can occur during any container movement Container movements in areas other than Room 147 and 170 are mitigated by the ***Building 991 filtered exhaust ventilation system*** Container movements in Rooms 147 and 170 while dock doors are closed are also mitigated by the system Container movements during receipt and shipment activities, when the dock doors are open, are assumed to not be mitigated by the ventilation system Therefore, more than half of the container movements will be mitigated

The risk and consequences of Container Explosion Scenario 1 will be presented for two situations 1) Case 1 (unmitigated) represents container explosions occurring in Room 147 or 170 while dock doors are open, and 2) Case 2 (mitigated) represents container explosions occurring at any other time

In summary, removal of analysis conservatism by **using a TRU waste drum versus a TRU waste box** and **using a more appropriate ARF and RF values** would continue to yield Risk Class II result for the CW No credit is taken in Case 1 for the expected inflow of air while dock doors are open that would tend to mitigate the container explosion scenario consequences Crediting the ***Building 991 filtered exhaust ventilation system*** and ***facility configuration*** controls would reduce the MOI and CW risk to Risk Class IV for Case 2 (*extremely unlikely* frequency, *low* consequences)

NPH/EE Scenario 1 – DBE Event-Induced Spill

A DBE event is postulated to occur impacting the POC and TRU waste storage areas in the Building 991 Complex TRU waste containers stored in Building 991 are considered to be susceptible to earthquake impacts Containers that are impacted may be breached by falling debris (e g , overhead cranes, heating, ventilating, and air conditioning (HVAC) ducts, etc) and other overhead equipment that is not seismically rated The building structure and roof is expected to remain intact in a DBE event and stacked waste containers are not expected to topple in a DBE event The exposed upper tier of waste containers is assumed to be susceptible to impact from the falling debris The breached containers from the falling debris do not spill the container contents from the breach since the breach is at the top or upper portion of the container

The postulated DBE scenario is considered to be an *unlikely* event with *high* consequences for the CW, *moderate* consequences for the MOI, and *moderate* consequences for the IW The MOI and the IW risk class for the scenario is Risk Class II The CW has Risk Class I scenario results

Acceptability of the risk class results for the CW and the MOI is based on the conservatism that is assumed in the analysis If a median χ/Q value (approximately an order of magnitude reduction in atmospheric dispersion) were used in the analysis, the CW consequences would be *moderate* and the MOI consequences would be *low* This would yield a reduction in the corresponding risk class for the CW and MOI Use of a more realistic MAR (*i e*, a factor of 2 reduction in MAR) concurrent with a median χ/Q value yields the same results

The DBE scenario does not take any credit for deposition and building retention of radioactive material that is released during the event If the ventilation system is not functioning, the ambient building leakpath factor is qualitatively judged to be less than 0 1 for an intact facility In the DBE event the building is assumed to remain intact Assuming an ambient building leakpath factor of 0 1 reduces the MOI consequences to *low* and the CW consequences to *moderate* This reduces the risk class to the MOI to Risk Class III and to the CW to Risk Class II

The damage ratios used in the analysis and the drum loading of the facility that is assumed are both conservative However, an order of magnitude conservatism from each of these analysis assumptions is not likely The combined effect of the two assumptions could result in an order of magnitude conservatism that, if removed, would lower the risk class for the MOI and for the CW

The immediate worker analysis is insensitive to analysis assumptions or credited controls due to the impact of the earthquake on the facility and the corresponding *moderate* radiological consequences to the immediate worker as a result of the falling debris incapacitating the IW The level of earthquake that is postulated would have similar effects on workers in most other buildings, on or off the Site

In summary, removal of analysis conservatism by using **median weather** and **using a more realistic MAR** (i.e., a factor of 2 reduction in MAR) would yield Risk Class III results for the MOI and Risk Class II results for the CW The risk to the IW remains as Risk Class II since an IW may be trapped by falling debris

Summary of Risk Dominant Accident Scenarios

Once analysis conservatism was removed, three of the dominant accident scenario cases remained high risk scenarios for at least one receptor The puncture of one (originally two) TRU waste containers yielded a CW Risk Class II scenario (*unlikely* frequency, *moderate* consequences), the container explosion accident scenario yielded a CW Risk Class II scenario (*extremely unlikely* frequency, *high* consequences), and the DBE event-induced spill accident scenario yielded a CW Risk Class II scenario (*unlikely* frequency, *moderate* consequences) and IW Risk Class II scenario (*unlikely* frequency, *moderate* consequences) following removal of some analysis conservatism and crediting a single tested stage of HEPA filtration in many cases

Consequences can be mitigated by HEPA filtration in many accident scenarios as long as the event occurs inside the facility in ventilated areas Given that most waste containers are stored in directly ventilated areas (*i e*, north waste storage/staging areas) or in indirectly ventilated areas (*i e*, Rooms 134, 135, 147, and 170), the reduction in scenario consequences by HEPA filtration can be credited for some of the scenarios but the dominant scenario cases would be at the dock when dock doors are open The credited HEPA filtration control is included in the TSRs as a Limiting Condition for Operation (LCO) Raising this control to a fully credited feature changes the risk class conclusions

The risk from accident scenarios that were not risk dominant scenarios (*i e*, *low* risk scenarios, Risk Class III or IV for all receptors) can be lowered, in many cases, as a result of the crediting of a single tested stage of HEPA filtration for mitigation of risk dominant accident scenarios Some other risk reduction measures that may not be necessary from a nuclear safety perspective, should be included, where possible Examples include (1) use of flammable gas cylinders with capacities or loaded to levels that are limited to a level necessary for the maintenance activity being performed and (2) preferential storage of POC containers rather than TRU waste containers in indirectly ventilated areas (*i e*, south waste container storage areas)

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Table 109 Risk Dominant Accident Scenarios

RISK DOMINANT ACCIDENT SCENARIO	ANALYZED RISK CLASS[1]			ADDITIONAL CONSIDERATIONS FOR RISK REDUCTION[1]			RISK REDUCTION REMARKS
	MOI	CW	IW	MOI	CW	IW	
Facility Fire Scenario 1 – 1 MW TRU Waste Drum Facility Fire Facility fire involving up to 3 TRU waste drums	Unlikely Moderate 0 26 $\boxed{\text{II}}$	Unlikely High 35 $\boxed{\text{I}}$	Unlikely Low N/A III	Unlikely Low <u>2 6E-4</u> <u>III</u>	Unlikely <u>Low</u> <u>0 035</u> III	N/A	Consequences reduced <u>crediting a single stage of tested HEPA filtration</u>
Facility Fire Scenario 2 – 2 MW TRU Waste Drum Facility Fire Facility fire involving up to 6 TRU waste drums	Extremely Unlikely Moderate 0 52 III	Extremely Unlikely High 71 $\boxed{\text{II}}$	Extremely Unlikely Low N/A IV	<u>Extremely Unlikely</u> <u>Low</u> <u>5 2E-4</u> <u>IV</u>	Extremely Unlikely <u>Low</u> <u>0 071</u> <u>IV</u>	N/A	Consequences reduced <u>crediting a single stage of tested HEPA filtration</u>
Facility Fire Scenario 3 - Medium to Large Wooden LLW Crate Facility Fire Facility fire involving up to 4 wooden LLW crates	Unlikely Low 0 0048 III	Unlikely Moderate 0 66 $\boxed{\text{II}}$	Unlikely Low N/A III	N/A	Unlikely Low 0 16 III	N/A	Consequences reduced assuming more realistic MAR values

Table 109 Risk Dominant Accident Scenarios

RISK DOMINANT ACCIDENT SCENARIO	ANALYZED RISK CLASS[1]			ADDITIONAL CONSIDERATIONS FOR RISK REDUCTION[1]			RISK REDUCTION REMARKS
	MOI	CW	IW	MOI	CW	IW	
Spill Scenario 1 - TRU Waste Drums Drop/Fall Spill involving a pallet of 55-gallon TRU waste drums	Anticipated Low 0 023 III	Anticipated Moderate 3 1 $\boxed{\text{I}}$	Anticipated Low N/A III	N/A	Anticipated Low 3 1E-3 III	N/A	Consequences reduced crediting a single stage of tested HEPA filtration
Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures Case B1 Puncture of 2 TRU waste drums during handling at dock while dock doors are open	Unlikely Low 0 046 III	Unlikely Moderate 6 2 $\boxed{\text{II}}$	Unlikely Low N/A III	N/A	Unlikely Moderate 3 1 $\boxed{\text{II}}$	N/A	Consequences reduced assuming puncture only involves a single TRU waste drum, rather than two drums, but consequences remained in the *moderate* bin
Puncture Scenario 1 - LLW, TRU, POC, and Type B Container Punctures Case B2 Puncture of 2 TRU waste drums during handling while dock doors are closed	Unlikely Low 0 046 III	Unlikely Moderate 6 2 $\boxed{\text{II}}$	Unlikely Low N/A III	N/A	Unlikely Low 6 2E-3 III	N/A	Consequences reduced crediting a single stage of tested HEPA filtration

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Table 109 Risk Dominant Accident Scenarios

RISK DOMINANT ACCIDENT SCENARIO	ANALYZED RISK CLASS[1]			ADDITIONAL CONSIDERATIONS FOR RISK REDUCTION[1]			RISK REDUCTION REMARKS
	MOI	CW	IW	MOI	CW	IW	
Container Explosion Scenario 1 - TRU Waste Box Container Explosion Case 1 Container explosion involving a single TRU waste box during handling at dock while dock doors are open	Extremely Unlikely Moderate 2 6 III	Extremely Unlikely High 350 $\boxed{\text{II}}$	Extremely Unlikely Moderate N/A III	N/A	Extremely Unlikely High 31 $\boxed{\text{II}}$	N/A	Consequences reduced assuming more appropriate ARF and RF values and assuming TRU waste drum (versus TRU waste box)
Container Explosion Scenario 1 - TRU Waste Box Container Explosion Case 2 Container explosion involving a single TRU waste box during handling while dock doors are closed	Extremely Unlikely Moderate 2 6 III	Extremely Unlikely High 350 $\boxed{\text{II}}$	Extremely Unlikely Moderate N/A III	N/A	Extremely Unlikely Low 0 35 IV	N/A	Consequences reduced crediting a single stage of tested HEPA filtration, but conservatism of analysis MAR, ARF, and RF values maintained (see Case 1)
NPH/EE Scenario 1 – DBE Event-Induced Spill DBE event causes overhead equipment to fall and breach TRU waste drums	Unlikely Moderate 0 35 $\boxed{\text{II}}$	Unlikely High 48 $\boxed{\text{I}}$	Unlikely Moderate N/A $\boxed{\text{II}}$	Unlikely Low 0 018 III	Unlikely Moderate 3 0 $\boxed{\text{II}}$	Unlikely Moderate N/A $\boxed{\text{II}}$	Consequences reduced assuming median χ/Q values & more realistic MAR, CW consequences dropped to *moderate* bin, IW consequences remain unchanged

[1] First value is frequency bin, second value is radiological dose consequence bin, third value is consequences in rem, fourth value is assigned risk class based upon frequency and consequences

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7. SAFETY ANALYSIS ASSUMPTIONS, FEATURES, AND REQUIREMENTS

Table 110 presents a summary listing of the general assumptions made (coded by the letter "G"), the assumptions made (coded by the letter "A"), the protective features credited (coded by the letter "F"), and the requirements imposed (coded by the letter "R") in the Safety Analysis These assumptions, features, and requirements were derived during the hazard evaluation and accident analysis of the Building 991 Complex and during the risk reduction evaluation of the dominant accident scenarios

The scenarios to which each assumption, feature, or requirement applies are listed in the table along with the impact of the assumption, feature, or requirement Scenarios identified during the hazard evaluation process presented in Section 4 3 1, *Hazard Evaluation Process*, are generally in the form of.

SCENARIO-NUMBER-ACTIVITY

and are displayed as left justified in Table 110 Scenarios identified during the bounding scenario selection process presented in Section 4 3 6, *Bounding Scenario Selection*, are generally in the form of

B-SCENARIO-NUMBER

and are displayed as centered in Table 110 Scenarios identified during the accident analysis process presented in Section 5, *Accident Analysis*, or evaluated in the dominant accident scenario discussion in Section 6, *Risk Dominant Accident Scenarios*, are generally in the form of

Scenario NUMBER

and are displayed as right justified in Table 110 If the accident analysis scenario labels are shown in *italicized* print, then the assumption/feature/requirement was indirectly credited and will not be shown on the scenario summary tables For example, if a scenario analysis that covers LLW and TRU waste containers is evaluated using only TRU waste containers, then General Assumption G2, dealing with LLW container MAR limits, may include the scenario in *italicized* print to indicate that the assumption was used in the selection of a bounding accident scenario even though the scenario summary table would not list the assumption If the accident analysis scenario labels are shown in **bold** print, then the assumption/feature/requirement was credited in the dominant scenario discussion for risk reduction

The impact of the assumption/feature/requirement on the Safety Analysis is presented in the last column This column also identifies any controls that were imposed based on the assumption/feature/requirement Controls identified (shown as ***bold italicized*** in the column) were carried forward into the FSAR TSRs

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G1	LLW generated under the GEN activity has negligible contamination and will yield *low* consequences in all cases	generally applied	Sets the potential consequences for many GEN activity scenarios Not a control, only an assumption of the safety analysis
G2	LLW containers contain no more than 0 5 grams (WG Pu equivalent) in metal drums and 3 grams in wooden or metal boxes	*Facility Fire Scenario 1* *Facility Fire Scenario 2* Facility Fire Scenario 3 Facility Fire Scenario 4 *Spill Scenario 1* *Spill Scenario 2* Puncture Scenario 1 *Facility Explosion Scenario 1* *NPH/EE Scenario 1* *NPH/EE Scenario 2* *NPH/EE Scenario 3*	Sets the potential MAR for many scenarios impacting LLW containers (3 grams for spills, punctures, and criticality potential) ***Container Radioactive Material Loading***
G3	Assumption deleted in Rev 1		
G4	TRU waste containers contain no more than 200 grams (WG Pu equivalent) in metal drums and 320 grams in metal boxes	Facility Fire Scenario 1 Facility Fire Scenario 2 Spill Scenario 1 Spill Scenario 2 Puncture Scenario 1 Container Explosion Scenario 1 Facility Explosion Scenario 1 NPH/EE Scenario 1 NPH/EE Scenario 2 NPH/EE Scenario 3	Sets the potential MAR for many scenarios impacting waste containers (200 grams for facility fires and container explosions, 320 grams for facility fires, spills, punctures, container explosions, and criticality potential) ***Container Radioactive Material Loading***
G5	A pallet of TRU waste drums contains no more than 4 drums and only 2 drums can be impacted by forklift tines	Spill Scenario 1 Puncture Scenario 1	Sets the potential MAR for many scenarios impacting pallets of waste containers (800 grams for pallet spills, material fires, and criticality potential, 400 grams for pallet punctures and material fires) Not a control, only an assumption of the safety analysis

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
G6	POC containers contain no more than 1,255 grams (WG Pu equivalent) in metal drums and 200 grams (fissile material) in metal drums	Puncture Scenario 1	**Sets the potential MAR for many scenarios impacting POC containers (1,255 grams for facility fires and container explosions)** ***Container Radioactive Material Loading***
G7	A pallet of POC drums contains no more than 4 drums and only 1 drum can be impacted by forklift tines	*Puncture Scenario 1*	**Sets the potential MAR for many scenarios impacting pallets of POC containers (5,020 grams for pallet spills, 1,255 grams for punctures, 800 grams for criticality potential)** **Not a control, only an assumption of the safety analysis**
G8	Type B containers cannot be impacted by activities other than the SNM and SURV activities due to their storage location and safeguards restrictions	*Puncture Scenario 1*	**Defines the potential interactions and corresponding types of containers for many scenarios** ***SNM Only Staged in Vaults***
G9	Type B containers are assumed to contain no more than 6,000 grams (WG Pu equivalent) of oxide	Puncture Scenario 1	**Sets the potential MAR for many scenarios impacting Type B containers (6,000 grams for facility fires, spills, punctures, and criticality potential)** **Not a control, only an assumption of the safety analysis**
G10	Type B containers containing pyrophoric material are assumed to contain no more than 2,000 grams (WG Pu equivalent) of metal	generally applied	**Sets the potential MAR for many scenarios impacting Type B pyrophoric material containers (2,000 grams for material fires)** **Not a control, only an assumption of the safety analysis**
G11	Type B shipping containers, POC containers, and TRU waste containers will not be opened in the Building 991 Complex	generally applied	**Defines the potential interactions for many scenarios** ***Containers Not Opened***
G12	TRU waste containers contain no more than 200 grams of fissionable material in drums	B-CRIT-1 B-CRIT-2	**Sets the potential MAR for criticality events involving TRU waste containers** ***Container Fissionable Material Loading***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A1	The CHEM, CON, GEN, MAINT, and SURV activities require a very limited amount of container movements	MFIRE-1-SURV, CHEM, CON, MAINT MFIRE-2-SURV, CHEM, CON, MAINT MFIRE-6-SURV, CHEM, CON, MAINT SPILL-1-GEN, SURV, CHEM, CON, MAINT SPILL-2-GEN, SURV, CHEM, CON, MAINT SPILL-5-GEN, SURV, CHEM, CON, MAINT SPILL-6-GEN, SURV, CHEM, CON, MAINT PUNCT-1-GEN, SURV, CHEM, CON, MAINT PUNCT-4-GEN, SURV, CHEM, CON, MAINT CRIT-1-GEN, SURV, CHEM, CON, MAINT CRIT-2-GEN, SURV, CHEM, CON, MAINT CRIT-3-GEN, SURV, CHEM, CON, MAINT B-SPILL-1 B-PUNCT-1 *Spill Scenario 1* *Puncture Scenario 1*	Reduces the likelihood of some direct interaction scenarios dealing with container movements, other than container explosion scenarios, by one frequency bin <u>Not a control, only an assumption of the safety analysis</u>
A2	Damaging high winds and heavy snows are *anticipated* events except over vaults, damaging lightning strikes are *anticipated* events, freezing events impacting the complex are *anticipated*, damaging heavy rains and flooding are *unlikely* events, facility collapse due to seismic events is *unlikely* except for below ground vaults, damaging tornadoes are *unlikely* events, damaging range fires are *extremely unlikely* events	MFIRE-3-SNM, WASTE MFIRE-8-SNM, WASTE SPILL-3-GEN, SNM, WASTE SPILL-7-GEN, WASTE PUNCT-3-GEN, SNM, WASTE PUNCT-6-GEN, WASTE CRIT-4-GEN, SNM, WASTE <u>*NPH/EE Scenario 1*</u> <u>*NPH/EE Scenario 2*</u> <u>*NPH/EE Scenario 3*</u>	Sets the likelihood of natural phenomena events <u>Not a control, only an assumption of the safety analysis</u>

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A3	Damaging tunnel failure and floor loading failures are *unlikely* events, damaging aircraft crashes are *extremely unlikely* events	MFIRE-3-SNM, WASTE MFIRE-8-SNM, WASTE SPILL-3-GEN, SNM, WASTE SPILL-7-GEN, WASTE PUNCT-3-GEN, SNM, WASTE PUNCT-6-GEN, WASTE CRIT-4-GEN, SNM, WASTE SPILL-3-SNM, WASTE [aircraft crash] PUNCT-3-SNM, WASTE [aircraft crash] CRIT-4-SNM, WASTE [aircraft crash] B-SPILL-1 B-SPILL-2 B-PUNCT-1 B-PUNCT-2 B-CRIT-1 *Spill Scenario 1* *Spill Scenario 2* *Puncture Scenario 1*	Sets the likelihood of some internal and external events Not a control, only an assumption of the safety analysis
A4	Natural gas system failure leading to an explosion impacting the facility is an *extremely unlikely* event	FEXPLO-1-GEN, WASTE FEXPLO-2-GEN, WASTE CRIT-5-GEN, WASTE B-FEXPLO-1 B-CRIT-2	Sets the likelihood for facility explosion events Not a control, only an assumption of the safety analysis
A5	Vault areas are not expected to be impacted by facility explosions involving natural gas	MFIRE-4-SNM FEXPLO-1-SNM CRIT-5-SNM	Reduces the likelihood of container failure, for containers located in vaults, from scenarios dealing with natural gas explosions to *Beyond Extremely Unlikely* Not a control, only an assumption of the safety analysis

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A6	The CHEM, CON, GEN, MAINT, RA, and SURV activities perform limited operations with material handling equipment	MFIRE-7-GEN, SURV, CHEM, CON, MAINT, RA SPILL-4-GEN, SURV, CHEM, CON, MAINT, RA SPILL-8-GEN, SURV, CHEM, CON, MAINT, RA PUNCT-2-GEN, SURV, CHEM, CON, MAINT, RA PUNCT-5-GEN, SURV, CHEM, CON, MAINT, RA CEXPLO-1-GEN, CHEM, CON, MAINT, RA CRIT-6-GEN, SURV, CHEM, CON, MAINT, RA B-SPILL-1 B-PUNCT-1 *Spill Scenario 1* *Puncture Scenario 1*	Reduces the likelihood of some indirect interaction scenarios dealing with material handling equipment impacts on other activity containers by one frequency bin Not a control, only an assumption of the safety analysis
A7	Due to the limited amount of waste generation under GEN and the expected locations for the activity, direct exposure of the waste container to propane or other flammable gases is considered to be a *beyond extremely unlikely* event	FFIRE-1-GEN	Reduces the likelihood of GEN activity waste container failure from scenarios dealing with direct exposure to flammable gases (*i e* torches) to *Beyond Extremely Unlikely* Not a control, only an assumption of the safety analysis
A8	The SNM activity performs operations with material handling equipment in proximity to metal waste containers but is *unlikely* to interact with hydrogen generating waste drums	CEXPLO-1-SNM	Reduces the likelihood of indirect interaction scenarios dealing with material handling equipment impacts on other activity hydrogen generating containers by one frequency bin Not a control, only an assumption of the safety analysis
A9	At least 10 kilograms of plutonium oxide is required to yield a criticality involving waste material	CRIT-1-GEN CRIT-2-GEN, WASTE, SURV, CHEM, CON, MAINT CRIT-3-GEN, WASTE, SURV, CHEM, CON, MAINT CRIT-4-GEN, WASTE CRIT-5-GEN, WASTE, CON, MAINT CRIT-6-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA B-CRIT-1 B-CRIT-2	Reduces the likelihood of criticalities from scenarios dealing with less than 10 kilograms of plutonium contaminated waste to *Beyond Extremely Unlikely* Not a control, only an assumption of the safety analysis

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A10	Pyrophoric materials (e g , uranium fines) are not introduced into the facility under the WASTE activity	MFIRE-1-WASTE, SURV, CHEM, CON, MAINT MFIRE-2-WASTE, SURV, CHEM, CON, MAINT MFIRE-3-WASTE MFIRE-4-WASTE, CON, MAINT MFIRE-5-GEN, WASTE, SURV, CHEM, CON, MAINT, RA MFIRE-6-WASTE, SURV, CHEM, CON, MAINT MFIRE-7-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA MFIRE-8-WASTE	Reduces the likelihood of pyrophoric material waste container failure from direct interaction scenarios or indirect equipment impact scenarios to *Beyond Extremely Unlikely* ***No TRU Pyrophoric***
A11	Assumption deleted Rev 1		
A12	Transport vehicle fires are *unlikely* events	FFIRE-2-GEN, SNM, WASTE B-FFIRE-2	Sets the likelihood of the event <u>Not a control, only an assumption of the safety analysis</u>
A13	Due to the limited amount of waste generation under GEN and the expected locations for the activity, exposure of the waste container to transport vehicle fires is considered to be an *unlikely* event	FFIRE-2-GEN	Reduces the likelihood of GEN activity waste container exposure to scenarios dealing with transport vehicle fires by one frequency bin <u>Not a control, only an assumption of the safety analysis</u>
A14	Due to the lower likelihood that transport vehicle fires deal with the diesel fuel on the vehicle and the protection afforded by the cargo bed of the trailer, transport vehicle fire propagation to waste containers is an *unlikely* event	FFIRE-2-GEN, WASTE B-FFIRE-2	Reduces the likelihood of waste container failure from scenarios dealing with transport vehicle fires by one frequency bin <u>Not a control, only an assumption of the safety analysis</u>
A15	Natural gas or propane explosions are not expected to occur following an aircraft crash event due to the fire associated with the event preventing the buildup of gases to explosive levels	FEXPLO-1 [aircraft crash] FEXPLO-2 [aircraft crash] CRIT-5 [aircraft crash]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following an aircraft crash to *Beyond Extremely Unlikely* <u>Not a control, only an assumption of the safety analysis</u>

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A16	Natural gas or propane explosions are not expected to occur following high wind or tornado events due to the wind dispersal of the flammable gases preventing the buildup of gases to explosive levels	FEXPLO-1 [high wind] FEXPLO-1 [tornado] FEXPLO-2 [high wind] FEXPLO-2 [tornado] CRIT-5 [high wind] CRIT-5 [tornado]	Reduces the likelihood of radioactive material container failure from scenarios dealing with natural gas or propane explosions following high wind or tornado events to *Beyond Extremely Unlikely* <u>Not a control, only an assumption of the safety analysis</u>
A17	Forces associated with waste storage area flooding following heavy rain, flooding, or freezing induced flooding events are not expected to be sufficient to result in waste container stack toppling	SPILL-4 [heavy rain] SPILL-4 [flooding] SPILL-4 [freezing] SPILL-8 [heavy rain] SPILL-8 [flooding] SPILL-8 [freezing]	Reduces the likelihood of radioactive material container failure from scenarios dealing with flooding following heavy rain, flooding, or freezing induced flooding events to *Beyond Extremely Unlikely* <u>Not a control, only an assumption of the safety analysis</u>
A18	Propane or other flammable gas torches are *unlikely* to breach both the outer drum and the inner pipe component of a POC container without intentional flame direction	B-FFIRE-3	Reduces the likelihood of POC container failure from scenarios dealing with flammable gas torch direct flame impingement breach of the container by one frequency bin <u>Not a control, only an assumption of the safety analysis</u>
A19	A drop/fall of banded TRU or low-level waste containers results in the equivalent release of material of one waste container	Spill Scenario 1 <u>NPH/EE Scenario 2</u>	Sets the potential MAR for the scenario impacting TRU or low-level waste containers ***Banding***
A20	The floor loading capacity of the hallways is adequate to handle the expected loads	*Spill Scenario 2*	Reduces the frequency of the scenario dealing with overloading the hallway floor to *Extremely Unlikely* <u>Not a control, only an assumption of the safety analysis</u>
A21	The number of drums breached due to structural failure of the hallway floor is the same in the spill and puncture scenarios	B-PUNCT-2 *<u>Spill Scenario 2</u>*	Defines the number of drums for the scenario so that one analysis can be used to address both scenarios <u>Not a control, only an assumption of the safety analysis</u>

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
A22	No more than 10% of contaminated waste fissionable material in breached waste containers will migrate out of containers and into solution in scenarios involving flooding or sprinkler actuation	B-CRIT-1 B-CRIT-2	Reduces the amount of material that can be collected in criticality scenarios involving breached containers and water <u>Not a control, only an assumption of the safety analysis</u>
F1	Type B shipping containers cannot be breached by falls from any heights expected during operation	MFIRE-1-SNM, SURV SPILL-1-SNM, SURV CRIT-2-SNM, SURV *<u>Spill Scenario 1</u>* *<u>NPH/EE Scenario 2</u>*	Reduces the likelihood of Type B shipping container failure from scenarios dealing with dropped containers to *Beyond Extremely Unlikely* ***Type B Shipping Container***
F2	POC containers cannot be breached by falls from any heights expected during operation	SPILL-1-WASTE, SURV, CHEM, CON, MAINT SPILL-4-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA *<u>Spill Scenario 1</u>* *<u>NPH/EE Scenario 2</u>*	Reduces the likelihood of POC container failure from scenarios dealing with dropped containers to *Beyond Extremely Unlikely* ***POC Container***
F3	Metal waste containers are *unlikely* to be breached by non-forklift tine impacts from material handling equipment expected during operation	MFIRE-2-WASTE, SURV, CHEM, CON, MAINT SPILL-2-GEN, WASTE, SURV, CHEM, CON, MAINT B-SPILL-1 Spill Scenario 1 Spill Scenario 2	Reduces the likelihood of metal waste container failure for scenarios dealing with material handling equipment impacts with containers, other than forklift tine puncture scenarios, by one frequency bin ***Metal Waste Container***
F4	Type B shipping containers cannot be breached by material handling equipment impacts expected during operation	MFIRE-2-SNM, SURV SPILL-2-SNM, SURV CRIT-3-SNM, SURV	Reduces the likelihood of Type B shipping container failure from scenarios dealing with material handling equipment impacts with containers to *Beyond Extremely Unlikely* ***Type B Shipping Container***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F5	POC containers cannot be breached by material handling equipment impacts expected during operation	SPILL-2-WASTE, SURV, CHEM, CON, MAINT	Reduces the likelihood of POC container failure from scenarios dealing with material handling equipment impacts with containers to *Beyond Extremely Unlikely* ***POC Container***
F6	Type B shipping containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	MFIRE-3-SNM MFIRE-8-SNM SPILL-3-SNM PUNCT-3-SNM CRIT-4-SNM SPILL-3-SNM [aircraft crash] PUNCT-3-SNM [aircraft crash] CRIT-4-SNM [aircraft crash] B-CRIT-1 *NPH/EE Scenario 1* *NPH/EE Scenario 2*	Reduces the likelihood of Type B shipping container failure for scenarios dealing with structural members impacting containers by one frequency bin ***Type B Shipping Container***
F7	POC containers are *unlikely* to be breached by structural member impacts due to impact angle requirements and weight needed to lead to failure	SPILL-3-WASTE PUNCT-3-WASTE CRIT-4-WASTE SPILL-3-WASTE [aircraft crash] PUNCT-3-WASTE [aircraft crash] CRIT-4-WASTE [aircraft crash] B-SPILL-2 B-PUNCT-2 B-CRIT-1 *Spill Scenario 2* *NPH/EE Scenario 1* *NPH/EE Scenario 2* *NPH/EE Scenario 3*	Reduces the likelihood of POC container failure for scenarios dealing with structural members impacting containers by one frequency bin ***POC Container***

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F8	Type B shipping containers cannot be breached by any external flammable gas explosions expected during operation	MFIRE-4-SNM FEXPLO-1-SNM CRIT-5-SNM *Facility Explosion Scenario 1*	Reduces the likelihood of Type B shipping container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely* ***Type B Shipping Container***
F9	POC containers cannot be breached by any external flammable gas explosions expected during operation	FEXPLO-1-WASTE, CON, MAINT CRIT-5-WASTE, CON, MAINT B-FEXPLO-1 B-CRIT-2 *Facility Explosion Scenario 1*	Reduces the likelihood of POC container failure from scenarios dealing with natural gas or propane explosions to *Beyond Extremely Unlikely* ***POC Container***
F10	Metal waste containers are *unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and waste packaging	MFIRE-6-WASTE, SURV, CHEM, CON, MAINT MFIRE-7-GEN, SNM, WASTE, SURV, CHEM CON, MAINT, RA PUNCT-1-GEN, WASTE, SURV, CHEM, CON, MAINT PUNCT-2-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA B-PUNCT-1 Puncture Scenario 1	Reduces the likelihood of metal waste container failure for scenarios dealing with forklift tines impacting containers by one frequency bin ***Metal Waste Container***
F11	Type B shipping containers are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and SNM packaging	MFIRE-6-SNM, SURV PUNCT-1-SNM, SURV B-PUNCT-1 Puncture Scenario 1	Reduces the likelihood of Type B shipping container failure for scenarios dealing with forklift tines impacting containers by two frequency bins ***Type B Shipping Container***

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F12	POC containers are *extremely unlikely* to be breached by forklift tine impacts due to impact angle requirements needed to lead to failure and waste packaging	PUNCT-1-WASTE, SURV, CHEM, CON, MAINT PUNCT-2-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA B-PUNCT-1 Puncture Scenario 1	Reduces the likelihood of POC container failure for scenarios dealing with forklift tines impacting containers by two frequency bins ***POC Container***
F13	Metal waste containers are *extremely unlikely* to be breached by internal hydrogen explosions due to metal waste container venting	CEXPLO-1-GEN, SNM, WASTE, SURV, CHEM, CON, MAINT, RA B-CEXPLO-1 Container Explosion Scenario 1	Reduces the likelihood of metal waste container failure for scenarios dealing with internal hydrogen explosions by two frequency bins ***Waste Container Vents***
F14	POC containers cannot be breached by any potential internal hydrogen explosions	CEXPLO-1-WASTE, SURV *Container Explosion Scenario 1*	Reduces the likelihood of POC container failure from scenarios dealing with internal hydrogen explosions to *Beyond Extremely Unlikely* ***POC Container***
F15	Type B shipping containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	FFIRE-2-SNM FFIRE-3-SNM B-FFIRE-1 *Facility Fire Scenario 1* *Facility Fire Scenario 2*	Reduces the likelihood of Type B shipping container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely* ***Type B Shipping Container***
F16	POC containers cannot be breached by any external fires expected during operation, except direct flame impingement torch fires	FFIRE-2-WASTE FFIRE-3-WASTE, CHEM, CON, MAINT, RA B-FFIRE-1 *Facility Fire Scenario 1* *Facility Fire Scenario 2*	Reduces the likelihood of POC container failure from scenarios dealing with facility fires, other than direct flame impingement torch fires, to *Beyond Extremely Unlikely* ***POC Container***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F17	Flammable gas containers are *unlikely* to be breached during use	FFIRE-3-CON, MAINT FFIRE-4-CON, MAINT FEXPLO-1-CON, MAINT FEXPLO-2-CON, MAINT CRIT-5-CON, MAINT B-FFIRE-3 B-FEXPLO-1 B-CRIT-2 Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4 Facility Explosion Scenario 1	Reduces the likelihood of explosion or fire scenarios due to use of flammable gases by one frequency bin ***Flammable Gas Container***
F18	Feature deleted Rev 1		
F19	Feature deleted Rev 1		
F20	Office area fires are prevented from propagating to waste storage areas by a combination of fire barriers and fire doors	B-FFIRE-1	Reduces the likelihood of fire propagation from the Office Area to waste storage areas by one frequency bin ***Office Area to Waste Area Fire Doors***
F21	Fire extinguishers are available and well maintained to allow personnel fire suppression actions	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fire growth from the small fires to medium fires by one frequency bin ***Fire Extinguishers***
F22	Automatic sprinkler systems are located in all waste storage areas, except Building 996, and in the Office Areas and are well maintained	B-FFIRE-1 Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fire growth from the medium fires to larger fires by one frequency bin ***Automatic Sprinkler Systems***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F23	Metal waste container lids cannot be removed from the containers due to internal overpressurize from exposure to expected fires	Facility Fire Scenario 1 Facility Fire Scenario 2	Reduces the likelihood of metal waste container fire-induced lid loss associated with expected fires to *Beyond Extremely Unlikely* ***Metal Waste Container***
F24	Metal waste container fires cannot propagate from container to container by exposure to expected fires	Facility Fire Scenario 1 Facility Fire Scenario 2	Reduces the likelihood of metal waste container fire container-to-container propagation associated with expected fires to *Beyond Extremely Unlikely* ***Metal Waste Container***
F25	Wooden waste containers prevent direct exposure of fires to container contents for expected fires	Facility Fire Scenario 3 Facility Fire Scenario 4	In combination with ***wooden waste crate liners***, reduces the consequences from LLW crate fires by two orders of magnitude ***Wooden Waste Container***
F26	Actuation of the automatic sprinkler systems will yield a flow alarm at the Fire Dispatch Center and will result in Fire Department response	Facility Fire Scenario 2 Facility Fire Scenario 4	Reduces the consequences of fires larger than those analyzed in the safety analysis ***Flow Alarms/Fire Department Response***
F27	Actuation of the smoke detection system will yield an alarm at the Fire Dispatch Center and will result in Fire Department response	Facility Fire Scenario 2	Reduces the consequences of fires larger than those analyzed in the safety analysis in Building 996 waste container storage areas ***Smoke Detectors/Fire Department Response***
F28	TRU and low-level waste containers cannot be breached by falls less than four feet	B-CRIT-1 Spill Scenario 1 NPH/EE Scenario 1 NPH/EE Scenario 2 NPH/EE Scenario 3	Reduces the likelihood of TRU and low-level waste container failure due to dropping from less than four feet to *Beyond Extremely Unlikely* ***Metal Waste Container***

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
F29	Metal waste drums cannot be breached by an external explosion peak overpressure less than 22 psig	B-CRIT-2 Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Metal Waste Drum***
F30	Building 991 filtered exhaust ventilation is directly applied to the north waste container storage areas and indirectly applied to the south waste container storage areas other than Room 166	Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	Reduces the radiological consequences to the collocated worker and the public from operationally induced facility fires, spills, punctures, and container explosions ***Building 991 Filtered Exhaust Ventilation System***
F31	Building 985 filtered exhaust ventilation is directly applied to some north waste container storage areas when the ventilation system is being used	Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	Reduces the radiological consequences to the collocated worker and the public from operationally induced facility fires, spills, punctures, and container explosions ***Building 985 Filtered Exhaust***
R1	Stacking of Type B shipping containers is prohibited	MFIRE-5-SNM SPILL-4-SNM CRIT-6-SNM B-SPILL-1 *Spill Scenario 1* *NPH/EE Scenario 2*	Reduces the likelihood of Type B shipping container spills associated with stack toppling to *Beyond Extremely Unlikely* ***Type B Shipping Container Stacking Restriction***
R2	Propane or other flammable gases are prohibited from vaults while SNM is present	FFIRE-1-SNM B-FFIRE-3	Reduces the likelihood of Type B shipping container breaches associated with direct flame impingement from torches to *Beyond Extremely Unlikely* ***Flammable Gas Prohibited in Vaults with SNM***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R3	Work controls are required to ensure that waste container direct exposure to propane or other flammable gas flames is an *extremely unlikely* event	FFIRE-1-WASTE, CON, MAINT B-FFIRE-1	Reduces the likelihood of metal waste container failure from scenarios dealing with direct exposure to flammable gases (i e, torches) to *Extremely Unlikely* ***Flammable Gas Not Near Containers***
R4	Type B shipping containers shall be designed and used in a manner to preclude a criticality as long as the containers remain intact	CRIT-1-SNM, SURV CRIT-2-SNM, SURV CRIT-3-SNM, SURV CRIT-7-SNM CRIT-8-SNM	Reduces the likelihood of intact Type B shipping container criticalities to *Beyond Extremely Unlikely* ***Criticality Controls***
R5	Waste containers in the Building 991 Complex shall be designed and used in a manner to preclude a criticality as long as the containers remain intact.	CRIT-1-WASTE, SURV, CHEM, CON, MAINT CRIT-7-WASTE CRIT-8-WASTE	Reduces the likelihood of intact waste container criticalities to *Beyond Extremely Unlikely* ***Criticality Controls***
R6	Requirement deleted Rev 1		
R7	Requirement deleted Rev 1		
R8	A combustible material and ignition source control program shall be implemented to make fires in areas containing staged, stored, or in-process (*i e* GEN activity) radioactive material *unlikely* events	FFIRE-3-GEN, SNM, WASTE, CHEM, CON, MAINT, RA FFIRE-4-GEN, WASTE, CHEM, CON, MAINT, RA B-FFIRE-3 Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4 <u>NPH/EE Scenario 1</u> <u>NPH/EE Scenario 2</u>	Reduces the likelihood of facility fires potentially impacting radioactive material to *Unlikely* ***Combustible Material Control*** ***Ignition Source Control***
R8a	Elements of combustible material control include • high heat release rate combustible material restrictions, • <u>no wooden crates</u> in internal waste storage areas, • combustibles have <u>five foot separation</u> from waste containers		
R8b	Elements of ignition source control include • <u>restrictions on smoking</u> in facilities, • <u>hot work permits</u>		

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R9	A hot work control program shall be implemented to make flammable gas explosions in areas containing staged, stored, or in-process (*i e* GEN activity) radioactive material *unlikely* events	FEXPLO-1-CON, MAINT FEXPLO-2-CON, MAINT CRIT-5-CON, MAINT B-FEXPLO-1 B-CRIT-2 Facility Explosion Scenario 1	Reduces the likelihood of facility explosions potentially impacting radioactive material by one frequency bin ***Hot Work Control***
R10	Type B shipping containers received at Building 991 shall meet the requirements of 1-W89-HSP-31 11	MFIRE-3-SNM MFIRE-6-SNM, SURV MFIRE-8-SNM	Reduces the likelihood of a Type B shipping container containing pyrophoric material to *unlikely* ***Container Radioactive Material Loading***
R11	Requirement deleted Rev 1		
R12	The Building 991 Complex will develop an Emergency Plan for the facilities in the complex	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4 Spill Scenario 1 Spill Scenario 2 Puncture Scenario 1 Container Explosion Scenario 1 NPH/EE Scenario 3	Reduces the exposure of the IW to releases ***Emergency Plan***
R13	Requirement deleted Rev 1		
R14	Requirement deleted Rev 1		
R15	Electrical systems in the Building 991 Complex are maintained sufficiently to prevent fires from hot shorts becoming *anticipated* events	Facility Fire Scenario 1 Facility Fire Scenario 2 Facility Fire Scenario 3 Facility Fire Scenario 4	Reduces the likelihood of fires from electrical system failures to *unlikely* or *extremely unlikely* events ***Electrical System Maintenance***

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Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R16	All wooden LLW crates stored in the Building 991 Complex shall have liners	Facility Fire Scenario 3 Facility Fire Scenario 4	In combination with ***wooden waste container***, reduces the consequences from LLW crate fires by two orders of magnitude ***Wooden Waste Crate Liners***
R17	No more than 50 wooden LLW crates may be stored in the West Dock Canopy waste storage area	Facility Fire Scenario 4	Limits the consequences from major LLW crate fires ***50 Wooden LLW Crate Limit***
R18	Requirement deleted Rev 1		
R19	Storage of waste containers in Corridor C is prohibited	B-CRIT-1 *Spill Scenario 2*	Eliminated analysis of structural failure of the corridor and its potential impact on the MOI, CW, and IW ***Storage of Waste Containers in Corridor C Prohibited***
R20	Waste containers stacked above the second tier will be banded	Spill Scenario 1 <u>NPH/EE Scenario 2</u>	Reduces the effective MAR of the scenario due to a pallet of TRU waste container dropping or falling from the third or fourth tier of the stack ***Banding***
R21	The Building 991 Complex will comply with Radiation Protection program guidance	Spill Scenario 1 Spill Scenario 2 Puncture Scenario 1	Reduces the exposure to the IW to releases ***Radiation Protection***
R22	Waste containers to be stored in the Building 991 Complex shall not contain liquids	Container Explosion Scenario 1	Reduces the likelihood of internal hydrogen explosions in containers by reducing the potential rate of hydrogen generation ***Liquids in Waste Prohibited***

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R23	The use of flammable gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is prohibited	B-FEXPLO-1 B-CRIT-2 Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Use of Flammable Gas in Room 135, Room 142, Room 143, Room 148, Room 158, and Building 996 is Prohibited***
R24	The flammable gas inventory in Room 134, Room 140/141/153, Room 151, Room 155, Room 166, Room 170, and Building 998 shall be limited to 150 ft^3	B-CRIT-2 Facility Explosion Scenario 1	Limits the MAR associated with facility explosions to containers breached by falling debris versus direct explosion impacts ***Flammable Gas Inventory***
R25	The glass pane window in Room 166 shall be covered or eliminated	B-FEXPLO-1 B-CRIT-2	Reduces the likelihood of gas getting into Room 166 with a subsequent gas explosion that can impact waste containers stored in the room to a *beyond extremely unlikely* event Superceded by Room 166 waste storage restrictions [R26]
R26	Room 166 can only be used to store POC containers, metal waste containers other than POC containers are prohibited from storage in Room 166	B-FEXPLO-1 B-CRIT-2 Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	In combination with ***POC container***, reduces the likelihood of a natural gas explosion in Room 166 impacting radioactive material to a *Beyond Extremely Unlikely* event ***Restrict Room 166 Storage to POC Containers***
R27	Facility doors are configured in a manner to allow the north waste container storage area ventilation to ventilate the south waste container storage areas, other than Room 166	Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	Reduces the radiological consequences to the collocated worker and the public from operationally induced facility fires, spills, punctures, and container explosions in the south waste container storage areas ***Building 991 Facility Configuration***

Table 110 Assumptions/Features/Requirements for Analyzed Scenarios

#	ASSUMPTION/ CREDITED FEATURE/REQUIREMENT	SCENARIO CODE	ASSUMPTION/FEATURE/ REQUIREMENT IMPACT
R28	Room 170 differential pressure with respect to atmosphere is verifiable	Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	Reduces the radiological consequences to the collocated worker and the public from operationally induced facility fires, spills, punctures, and container explosions in the south waste container storage areas ***Room 170 Differential Pressure***
R29	Operations in Rooms 147 and 170 are restricted while Room 170 dock doors are open	Dominant Facility Fire Scenario 1 Dominant Facility Fire Scenario 2 Dominant Spill Scenario 1 Dominant Puncture Scenario 1 Dominant Container Explosion Scenario 1	Reduces the radiological consequences to the collocated worker and the public from operationally induced facility fires, spills, punctures, and container explosions in the south waste container storage areas ***Rooms 147 and 170 Operations Restrictions***
R30	Containers may not be stacked above a second tier during Room 170 receipt and shipment operations	Dominant Spill Scenario 1	Reduces the likelihood of operationally induced spills in Room 170 while dock doors are open ***No Stacking Above Second Tier While Dock Doors Open***

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APPENDIX A

NSTR-011-98

SAFETY ANALYSIS FOR BUILDING 991 COMPLEX
FINAL SAFETY ANALYSIS REPORT

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The following pages contain output from Microsoft Excel spreadsheets and from the RADIDOSE spreadsheet These spreadsheets provide the information necessary to reproduce the calculations used in this document

For the Microsoft Excel spreadsheets, two printouts are provided The first page of the spreadsheet provides the results of the calculations The second and following pages (if necessary) provide the formulas used in the calculation

One page for each RADIDOSE printout is provided This page shows all of the inputs and displays the results of the calculation The scenario descriptions are provided in a block of text on the printout The information/assumptions used in developing the RADIDOSE spreadsheets is provided below The first column identifies the RADIDOSE input name and the second column provides information on where the input was derived from for each of the spreadsheets

RADIDOSE INPUT	REMARKS
Scenario (1 - 7)	Information concerning the Scenario input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Material (1 - 8)	Information concerning the Material input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Meteorology (1 - 2)	Default was to use "95th Percentile" "Median" was used to show effects of modeling conservatism's
Breathing Rate (1 - 3)	Use "Heavy Activity" as explained in the *Radiological Risk* section of the NSTR
Form of Material (1 - 11)	Information concerning the Form of Material input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Solubility Class (1 - 3)	Use Solubility Class "W" for Spill 1, Puncture 1, and Container Explosion 1 scenarios Input for other accident scenarios may be either Solubility Class "W" or "Y" since default Dose Conversion Factor will be overridden
Damage Ratio	Information concerning the Damage Ratio input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Material at Risk (g)	Information concerning the Material at Risk input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Ambient Leakpath Factor (not HEPA)	Set at "1 0" as discussed in *Radiological Risk* section of NSTR unless changed in individual accident analysis scenario discussion
TNT Explosion Equivalent (g)	Use "0" in all scenarios
Mass of Liquid, if Applicable (g)	Use "0" in all scenarios
Plume Release Duration (min)	Information concerning the Plume Release Duration input is provided in the text of the NSTR for each of the RADIDOSE spreadsheets
Least Distance to Site Boundary (m)	Set per discussion provided in *Radiological Risk* section of NSTR
Airborne Release Fraction	Use default value unless changed in accident analysis scenario discussion
Respirable Fraction	Use default value unless changed in accident analysis scenario discussion
Breathing Rate (m^3/s)	Use default value in all scenarios

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RADIDOSE INPUT	REMARKS
Dose Conversion Factor (rem/g)	Use default value for Spill 1, Puncture 1, and Container Explosion 1 scenarios Use blended value of **3.3E+7** for Facility Fire 1, Facility Fire 2, Spill 2, Facility Explosion 1, NPH/EE 1, and NPH/EE 2 accident scenarios This blended value is based on the assumption that 20% of the drums involved in the accident require the use of Solubility Class "W" and 80% of the drums involved in the accident require the use of Solubility Class "Y" [(4 35E+07 * 0 2) + (3 03E+07 * 0 8) = 3 3E+07] Use blended value of **3 07E+07** for Facility Fire 3 and Facility Fire 4 accident scenarios This blended value is based on the assumption that 3% of the LLW containers involved in an accident require the use of Solubility Class "W" and 97% of the LLW containers involved in an accident required the use of Solubility Class "Y"

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	3 18E+00	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 60 calculation
Moderate consequences for CW in spill

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3.6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	3 18E+00			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 3 18E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4 9E-01	3 6E-03
One	4 9E-04	3 6E-06
Two	9 9E-07	7 3E-09
Three	2.0E-09	1 5E-11
Four	4 0E-12	2.9E-14

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	1.57E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 60 calculation
High consequences for CW in spill

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	1 57E+02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 1 57E-01

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2 4E+01	1 8E-01
One	2 4E-02	1 8E-04
Two	4 9E-05	3 6E-07
Three	9 8E-08	7 2E 10
Four	2 0E-10	1 4E 12

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	6.30E-02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario:

NSTR-011-98, Revision 2
Table 60 calculation
Moderate consequences for CW in fire

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-02	Y		5 0E-02
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3.6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	6 30E-02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 3 15E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4 9E-01	3 6E-03
One	4 9E-04	3 6E-06
Two	9 8E-07	7 2E-09
Three	2.0E-09	1 4E-11
Four	3 9E-12	2.9E-14

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	3.10E+00	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 60 calculation
High consequences for CW in fire

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-02	Y		5 0E-02
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	3 10E+00			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 1 55E-01

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2 4E+01	1 8E-01
One	2 4E-02	1 8E-04
Two	4 8E-05	3 5E-07
Three	9 6E-08	7 1E-10
Four	1 9E 10	1 4E-12

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	5	Overpressure
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	3.18E+00	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N) =	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 60 calculation
Moderate consequences for CW in
container explosion

Version 1 2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3.6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	3 18E+00			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 3 18E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4 9E-01	3 6E-03
One	4 9E-04	3 6E-06
Two	9 9E-07	7 3E-09
Three	2 0E-09	1 5E-11
Four	4 0E-12	2 9E-14

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1 7) =	5	Overpressure
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1.000	
Material at Risk (g) =	1.57E+02	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 60 calculation
High consequences for CW in
container explosion

Version 1 2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	1 57E+02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 1 57E-01

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2.4E+01	1 8E-01
One	2 4E-02	1 8E-04
Two	4 9E-05	3 6E-07
Three	9 8E-08	7 2E 10
Four	2 0E 10	1 4E-12

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1 7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	6 00E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 85 - Facility Fire Scenario 1
1-MW TRU Waste Drum Fire
Blended DCF

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-04	Y		5 0E-04
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3.6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3.30E+07	3.30E+07
Effective MAR, Including DR (g) =	6 00E+02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3.5E+01	2.6E-01
One	3.5E-02	2.6E-04
Two	7 1E-05	5 2E-07
Three	1 4E-07	1 0E-09
Four	2.8E-10	2.1E-12

Respirable Initial Source Term (g) = 3 00E-01

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	1.20E+03	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98 Revision 2
Table 86 - Facility Fire Scenario 2
2 MW TRU Waste Drum Fire
Blended DCF

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-04	Y		5 0E-04
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3 30E+07	3 30E+07
Effective MAR, Including DR (g) =	1 20E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	7 1E+01	5 2E-01
One	7 1E-02	5 2E-04
Two	1 4E-04	1 0E-06
Three	2 8E-07	2 1E-09
Four	5 7E 10	4 2E 12

Respirable Initial Source Term (g) = 6 00E-01

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1 7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	1 20E+01	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 87 - Facility Fire Scenario 3
Medium to large wooden LLW crate facility fire
Blended DCF

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-04	Y		5 0E-04
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3.07E+07	3 07E+07
Effective MAR, Including DR (g) =	1 20E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	6.6E-01	4 8E-03
One	6 6E-04	4 8E-06
Two	1 3E-06	9 7E-09
Three	2.6E-09	1 9E-11
Four	5 3E-12	3 9E-14

Respirable Initial Source Term (g) = 6 00E-03

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire Lofted Plum
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	1.50E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	30	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 88 - Facility Fire Scenario 4
Major wooden LLW crate facility fire
Blended DCF

Version 1 2

Default Parameters	Lofted Values	Non-Lofted X/Q	Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-04		Y		5 0E-04
Respirable Fraction =	1 0E+00		Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04		Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07		N	3.07E+07	3 07E+07
Effective MAR, Including DR (g) =	1 50E+02				
Plume Expansion Factor =	1 246				
Collocated Worker χ/Q (s/m^3) =	2 88E-04	7 98E-03			
Public χ/Q (s/m^3) =	8 19E-06	5 86E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00				

Doses that credit HEPA filtration are based upon non-lofted X/Q values

CW at 100 m (non-lofted), 100 m (lofted); MOI at 2367 m (non-lofted) 4200 m (lofted)

Respirable Initial Source Term (g) = 7 50E-02

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2.4E-01	6 8E-03
One	6 6E-03	4 9E-05
Two	1 3E-05	9 7E-08
Three	2 6E-08	1 9E 10
Four	5 3E-11	3 9E-13

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0.250	
Material at Risk (g) =	8 00E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 92 - Spill Scenario 1
TRU waste drums drop/fall

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3.6E-04	Y		3.6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	2.00E+02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 2 00E-02

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3 1E+00	2.3E-02
One	3 1E-03	2 3E-05
Two	6.2E-06	4 6E-08
Three	1 2E-08	9 1E-11
Four	2 5E-11	1 8E-13

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 100	
Material at Risk (g) =	2.00E+04	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 93 - Spill Scenario 2
Facility structural failure spill
Blended DCF

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3 30E+07	3 30E+07
Effective MAR, Including DR (g) =	2 00E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 2 00E-01

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2 4E+01	1 7E-01
One	2 4E-02	1 7E-04
Two	4 7E-05	3 5E-07
Three	9 4E-08	6 9E-10
Four	1 9E 10	1 4E 12

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	2	Uncon Non-com
Solubility Class (1-3) =	2	W
Damage Ratio =	0 100	
Material at Risk (g) =	3 00E+00	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 96 - Puncture Scenario 1
LLW container puncture

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3.6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	3.00E-01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4 7E-02	3 4E-04
One	4 7E-05	3.4E-07
Two	9 3E-08	6 9E-10
Three	1 9E-10	1 4E-12
Four	3.7E-13	2.7E-15

Respirable Initial Source Term (g) = 3 00E-04

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	2	Uncon Non-com
Solubility Class (1-3) =	2	W
Damage Ratio =	0.100	
Material at Risk (g) =	4 00E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98 Revision 2
Table 96 - Puncture Scenario 1
TRU container puncture

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	4 00E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	6 2E+00	4 6E-02
One	6 2E-03	4 6E-05
Two	1 2E-05	9 1E-08
Three	2 5E-08	1 8E-10
Four	5 0E 11	3 7E-13

Respirable Initial Source Term (g) = 4 00E-02

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1 11) =	2	Uncon Non-com
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	8 83E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 96 - Puncture Scenario 1
POC container puncture

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	N	2.0E-03	2 0E-03
Respirable Fraction =	1 0E+00	N	1 0E-02	1 0E-02
Breathing Rate (m^3/s) =	3.6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	8 83E+02			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 1 77E-02

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	2.7E+00	2.0E-02
One	2.7E-03	2.0E-05
Two	5 5E-06	4 0E-08
Three	1 1E-08	8 1E-11
Four	2 2E-11	1 6E-13

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	6	Powder
Solubility Class (1-3) =	3	Y
Damage Ratio =	1.000	
Material at Risk (g) =	6.00E+03	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 96 - Puncture Scenario 1
Type B container puncture

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	2 0E-03	Y		2 0E-03
Respirable Fraction =	3 0E-01	Y		3 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	3 03E+07	Y		3 03E+07
Effective MAR, Including DR (g) =	6 00E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 3 60E+00

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3 9E+02	2 9E+00
One	3 9E-01	2 9E-03
Two	7 8E-04	5 7E-06
Three	1 6E-06	1 1E-08
Four	3 1E-09	2 3E 11

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Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	5	Overpressure
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	6	Powder
Solubility Class (1-3) =	2	W
Damage Ratio =	0 100	
Material at Risk (g) =	3 20E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 98 - Container Explosion Scenario 1
TRU waste box container explosion

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	N/A	N	1 0E-01	1 0E-01
Respirable Fraction =	N/A	N	7 0E-01	7 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3.6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	3.20E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	3 5E+02	2.6E+00
One	3.5E-01	2.6E-03
Two	7 0E-04	5 1E-06
Three	1 4E-06	1 0E-08
Four	2 8E-09	2 0E-11

Respirable Initial Source Term (g) = 2 24E+00

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1 000	
Material at Risk (g) =	2.00E+03	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 101 - Facility Explosion Scenario 1
Explosion in waste container storage area
Blended DCF

Version 1.2

Default Parameters		Change Options		
		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3 30E+07	3 30E+07
Effective MAR, Including DR (g) =	2 00E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	2 4E+01	1 7E-01
One	2 4E-02	1 7E-04
Two	4 7E-05	3 5E-07
Three	9 4E-08	6 9E 10
Four	1 9E 10	1 4E-12

Respirable Initial Source Term (g) = 2 00E-01

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 005	
Material at Risk (g) =	8 06E+05	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario.

NSTR-011-98, Revision 2
Table 106 - NPH/EE Scenario 1
DBE event-induced spill
Blended DCF

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3.6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3.30E+07	3 30E+07
Effective MAR, Including DR (g) =	4 03E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	CW (rem)	MOI (rem)
Zero	4 8E+01	3.5E-01
One	4 8E-02	3.5E-04
Two	9 5E-05	7 0E-07
Three	1 9E-07	1 4E-09
Four	3 8E-10	2 8E-12

Respirable Initial Source Term (g) = 4 03E-01

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 025	
Material at Risk (g) =	8.06E+05	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Table 107 - NPH/EE Scenario 2
BDBE event-induced spill
Blended DCF

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3 30E+07	3 30E+07
Effective MAR, Including DR (g) =	2 02E+04			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	CW (rem)	MOI (rem)
Zero	2 4E+02	1 7E+00
One	2 4E-01	1 7E-03
Two	4 8E-04	3 5E-06
Three	9 5E-07	7 0E-09
Four	1 9E-09	1 4E 11

Respirable Initial Source Term (g) = 2 02E+00

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1 11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 015	
Material at Risk (g) =	1 70E+05	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario.

NSTR-011-98, Revision 2
Table 108 - NPH/EE Scenario 3
Heavy snow event-induced spill
Blended DCF

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3.30E+07	3 30E+07
Effective MAR, Including DR (g) =	2.55E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	3.0E+01	2.2E-01
One	3 0E-02	2 2E-04
Two	6 0E-05	4 4E-07
Three	1 2E-07	8 8E-10
Four	2 4E-10	1 8E-12

Respirable Initial Source Term (g) = 2.55E-01

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	1	Median
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1.000	
Material at Risk (g) =	1.20E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Risk Dominant Facility Fire Scenario 3
Medium to large wooden LLW crate facility fire
Blended DCF - Median weather

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	5 0E-04	Y		5 0E-04
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3 07E+07	3 07E+07
Effective MAR, Including DR (g) =	1 20E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	1 26E-03			
Public χ/Q (s/m^3) =	7 53E-06			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	8 4E-02	5 0E-04
One	8 4E-05	5 0E-07
Two	1 7E-07	1 0E-09
Three	3 3E 10	2 0E-12
Four	6 7E 13	4 0E-15

Respirable Initial Source Term (g) = 6 00E-03

469

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire Lofted Plum
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1.000	
Material at Risk (g) =	1.20E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0.000

Describe Scenario

NSTR-011-98, Revision 2
Risk Dominant Facility Fire Scenario 3
Medium to large wooden LLW crate facility fire
Blended DCF - Lofted plume

Version 1.2

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-04	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.6E-04	
Dose Conversion Factor (rem/g-mix) =	4.35E+07	
Effective MAR, Including DR (g) =	1.20E+01	
Plume Expansion Factor =	1.000	
Collocated Worker χ/Q (s/m^3) =	3.59E-04	9.94E-03
Public χ/Q (s/m^3) =	1.02E-05	7.30E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Change Options: Accept Default?	New Value	Value Used
Y		5.0E-04
Y		1.0E+00
Y		3.6E-04
N	3.07E+07	3.07E+07

Doses that credit HEPA filtration are based upon non-lofted X/Q values

CW at 100 m (non-lofted), 100 m (lofted); MOI at 2367 m (non-lofted), 4200 m (lofted)

Respirable Initial Source Term (g) = 6.00E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	2.4E-02	6.8E-04
One	6.6E-04	4.8E-06
Two	1.3E-06	9.7E-09
Three	2.6E-09	1.9E-11
Four	5.3E-12	3.9E-14

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	2	Fire Non-lofted
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	1.000	
Material at Risk (g) =	3.00E+00	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0.000

Describe Scenario

NSTR-011-98, Revision 2
Risk Dominant Facility Fire Scenario 3
Medium to large wooden LLW crate facility fire
Blended DCF - More realistic MAR

Version 1.2

Default Parameters	
Airborne Release Fraction =	5.0E-04
Respirable Fraction =	1.0E+00
Breathing Rate (m^3/s) =	3.6E-04
Dose Conversion Factor (rem/g-mix) =	4.35E+07
Effective MAR, Including DR (g) =	3.00E+00
Plume Expansion Factor =	1.000
Collocated Worker χ/Q (s/m^3) =	9.94E-03
Public χ/Q (s/m^3) =	7.30E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00

Change Options: Accept Default?	New Value	Value Used
Y		5.0E-04
Y		1.0E+00
Y		3.6E-04
N	3.07E+07	3.07E+07

Respirable Initial Source Term (g) = 1.50E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	1.6E-01	1.2E-03
One	1.6E-04	1.2E-06
Two	3.3E-07	2.4E-09
Three	6.6E-10	4.8E-12
Four	1.3E 12	9.7E-15

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	2	Uncon Non-com
Solubility Class (1-3) =	2	W
Damage Ratio =	0 100	
Material at Risk (g) =	2.00E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2,367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Risk Dominant Puncture Scenario 1
TRU container puncture
Only single TRU drum involved in puncture

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	2.00E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 2 00E-02

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3 1E+00	2 3E-02
One	3 1E-03	2 3E-05
Two	6 2E-06	4 6E-08
Three	1 2E-08	9 1E-11
Four	2 5E-11	1 8E-13

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	5	Overpressure
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 100	
Material at Risk (g) =	2.00E+02	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario

NSTR-011-98, Revision 2
Risk Dominant Container Explosion Scenario 1
TRU Waste Box Container Explosion
More realistic ARF and RF values and TRU drum

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E+00	Y		1 0E+00
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	Y		4 35E+07
Effective MAR, Including DR (g) =	2 00E+01			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	9 94E-03			
Public χ/Q (s/m^3) =	7 30E-05			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

Respirable Initial Source Term (g) = 2 00E-02

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3 1E+00	2 3E-02
One	3 1E-03	2 3E-05
Two	6 2E-06	4 6E-08
Three	1 2E-08	9 1E-11
Four	2 5E 11	1 8E 13

471

Non-Criticality Accidents

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-2) =	1	Median
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1 11) =	1	Confined Mat
Solubility Class (1-3) =	2	W
Damage Ratio =	0 005	
Material at Risk (g) =	4 03E+05	
Ambient Leakpath Factor (not HEPA) =	1 00E+00	
TNT Explosion Equivalent (g) =		
Mass of Matrix, if Applicable (g) =		
Plume/Release Duration (min) =	10	
Least Distance to Site Boundary (m) =	2 367	
Evaluate Non-Criticality Accident? (Y/N)	Y	

User-Specified Isotopic Mix	
Isotope	Mass Fraction
SUM	0 000

Describe Scenario:

NSTR-011-98, Revision 2
Risk Dominant NPH/EE Scenario 1
DBE event-induced spill
Blended DCF, Median weather more realistic MAR

Version 1.2

Default Parameters		Accept Default?	New Value	Value Used
		Change Options		
Airborne Release Fraction =	1 0E-03	Y		1 0E-03
Respirable Fraction =	1 0E-01	Y		1 0E-01
Breathing Rate (m^3/s) =	3 6E-04	Y		3 6E-04
Dose Conversion Factor (rem/g-mix) =	4 35E+07	N	3.30E+07	3.30E+07
Effective MAR, Including DR (g) =	2 02E+03			
Plume Expansion Factor =	1 000			
Collocated Worker χ/Q (s/m^3) =	1 26E-03			
Public χ/Q (s/m^3) =	7 53E-06			
Ambient Leakpath Factor (Not HEPA) =	1 00E+00			

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3.0E+00	1 8E-02
One	3 0E-03	1 8E-05
Two	6 0E-06	3 6E-08
Three	1.2E-08	7 2E-11
Four	2 4E-11	1 4E-13

Respirable Initial Source Term (g) = 2 02E-01

NPH/EE Scenario - Aircraft Crash Calculation

Aircraft Wingspan ft	Building Length ft	Building Width ft	Building Height ft	mean cot ϕ	Skid Distance ft
50	260	100	20	8 2	68

R ft

278 57

A_f ft^2	A_s ft^2	A_{eff} ft^2	A_{eff} mi^2
89,218 57	22,342 61	111,561 18	4 00E-03

Crash frequency per year per square mile (From EPTR-004-97)

7 67E-04

Building dimensions exclude office area No adjustment for impact angle or skid distance

Building specific crash frequency per year

3 07E-06

473

Aircraft Wingspan ft	Building Length ft.	Building Width ft	Building Height ft	mean cot ϕ	Skid Distance ft	Percent of 360° radius valid for impact
50	40	38	20	8.2	0	50%

R ft			
55 17			

A_f ft^2	A_s ft^2	A_{eff} ft^2	A_{eff} mi^2
21,523 28	-	21,523 28	7 72E-04

Crash frequency per year per square mile (From EPTR-004-97)

7 67E-04

Building specific crash frequency per year

5 92E-07

Critical area specific crash frequency per year

2 96E-07

For Room 166 in Building 991 50% radius based on diagonal from NE corner to SW corner Skid distance set to 0 because the floor of Room 170 is raised from ground level, 3 large utility poles are directly east of the room, Building 989, a concrete block building is SE of the room, and wetlands, which reduce skid distance, are east of the room

474

Aircraft Wingspan ft	Building Length ft	Building Width ft	Building Height ft	mean cot ϕ	Skid Distance ft	Percent of 360° radius valid for impact
50	100	38	25	8.2	0	50%

R ft

106 98

A_f ft^2	A_s ft^2	A_{eff} ft^2	A_{eff} mi^2
39,532 39	-	39,532 39	1 42E-03

Crash frequency per year per square mile (From EPTR-004-97)

7 67E-04

Building specific crash frequency per year

1 09E-06

Critical area specific crash frequency per year

5 44E-07

For Room 170 in Building 991 50% radius based on diagonal from NW corner to SE corner Skid distance set to 0 because the floor of Room 170 is raised from ground level and retaining wall west of building will stop many impacts

475

Aircraft Wingspan ft.	Building Length ft.	Building Width ft.	Building Height ft.	mean cot ϕ	Skid Distance ft.
50	260	100	20	8.2	68

R ft.

=SQRT(B2^2+C2^2)

A_f ft^2	**A_s ft^2**	**A_{eff} ft^2**	**A_{eff} mi^2**
=(A2+A5)*D2*E2+(2*B2*C2*A2/A5)+B2*C2	=(A2+A5)*F2	=A8+B8	=D8/5280^2

Building dimensions exclude office area   No adjustment for impact angle or skid distance

Crash frequency per year per square mile (From EPTR-004 97)

0 000767

Building specific crash frequency per year

=A11*E8

476

Aircraft Wingspan ft.	Building Length ft.	Building Width ft.	Building Height ft.	mean cot ϕ	Skid Distance ft.	Percent of 360° radius valid for impact
50	40	38	20	8 2	0	0.5

R ft.
=SQRT(B2^2+C2^2)

A_f ft^2	A_s ft^2	A_{eff} ft^2	A_{eff} mi^2
=(A2+A5) D2 E2+(2 B2 C2*A2/A5)+B2 C2	=(A2+A5) F2	=A8+B8	=D8/5280^2

Crash frequency per year per square mile (From EPTR-004-97)
0 000767

Building specific crash frequency per year

=A11 E8

Critical area specific crash frequency per year

=A14*G2

For Room 166 in Building 991 50% radius based on diagonal from NE corner to SW corner Skid distance set to 0 because the floor of Room 170 is raised from ground level, 3 large utility poles are directly east of the room Building 989 a concrete block building is SE of the room and wetlands which reduce skid distance are east of the room

477

Aircraft Wingspan ft.	Building Length ft.	Building Width ft.	Building Height ft.	mean cot ϕ	Skid Distance ft.	Percent of 360° radius valid for impact
50	100	38	25	8.2	0	0 5

R ft.
=SQRT(B2^2+C2^2)

A_f ft²	A_s ft²	A_{eff} ft²	A_{eff} mi²
=(A2+A5) D2 E2+(2 B2*C2 A2/A5)+B2 C2	=(A2+A5)*F2	=A8+B8	=D8/5280^2

Crash frequency per year per square mile (From EPTR-004-97)
0 000767

Building specific crash frequency per year
=A11 E8

Critical area specific crash frequency per year
=A14 G2

For Room 170 in Building 991 50% radius based on diagonal from NW corner to SE corner Skid distance set to 0 because the floor of Room 170 is raised from ground level and retaining wall west of building will stop many impacts